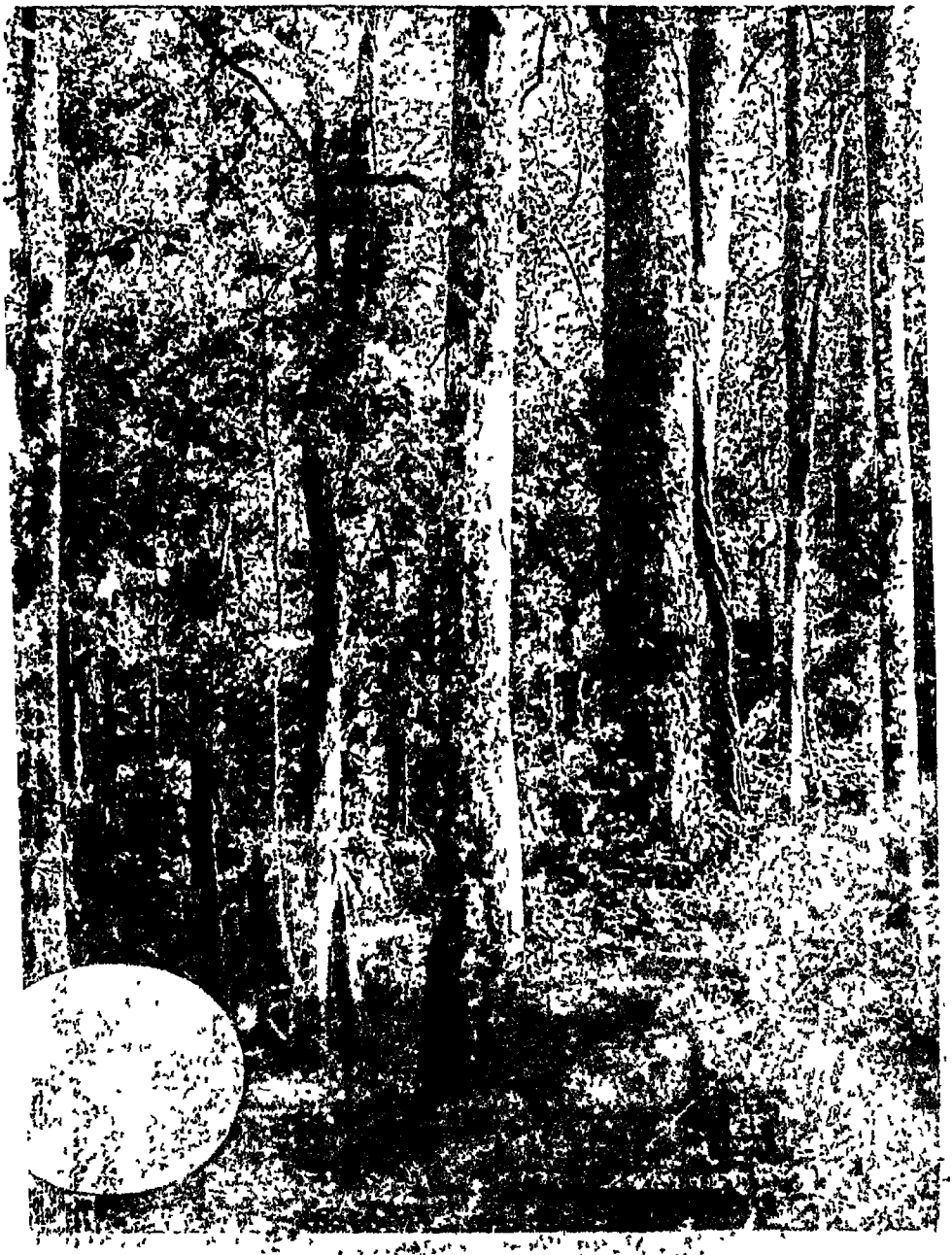
FOREST RESEARCH IN INDIA, 1934-35

PART II.—PROVINCIAL REPORTS.



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FOREST RESEARCH IN INDIA, 1934-35.

PART II.—PROVINCIAL REPORTS.

CHAPTER I.

GENERAL.

An increasing amount of research has been undertaken in the provinces, to a great extent in consultation or in co-operation with the Forest Research Institute, and many interesting and valuable results have been attained. Nearly all provinces now have silvicultural research officers, and several have also got gazetted assistants to help them, both indicating that the value and importance of forest research in accelerating and cheapening production and in improving the financial results of forest management is being more fully realised. The expenditure on forest research is infinitesimal when the cumulative value of the results is considered.

In relation to the provinces the chief function of the Forest Research Institute is necessarily advisory, as the majority of the problems dealt with by provincial research officers are of local importance, and the detailed work has to be carried out by the provinces themselves. Several All-India co-operative investigations are however in progress, the most notable of which are the teak seed origin investigation, and the numerous co-ordinated experiments in methods of bamboo management that have been started throughout India in the different provinces. The silvicultural conference held at Dehra Dun in October 1934 proved of great value in enabling the various provincial research officers to obtain a more intimate first hand knowledge of the work that was being undertaken in other provinces.

In Assam there was no silviculturist but silvicultural research work was being organised by the Botanical Officer. Most investigations initiated by the territorial staff are still in the preliminary stages. It was found that natural regeneration of *Terminalia myriocarpa* can be increased by strip fellings leaving rows of mother trees at right angles to the prevailing wind. Nursery experiments with many indigenous

species have been taken in hand. Pure *Gmelina arborea* plantations have been definitely condemned and experimental mixed plantations of *Artocarpus chaplasha* and *Dipterocarpus turbinatus* with the *Gmelina* have been started. Experiments in checking the spread of *Eupatorium* in sal plantations by closer spacing are in progress.

In Bihar and Orissa experiments have been started to find out if fire protection and manuring will conserve and improve the yield of *sabai* grass (*Pollinidium angustifolium*) in plantations. In both the dry grassy type as well as in moderately damp sal forests, fire protection has encouraged the natural regeneration of sal. Burning in coppice coupes is found to cause the production of multiple shoots. Experience has shown that the best time to plant teak stumps in Bihar is immediately after the first shower of rains, early in June. An irrigation experiment by contour trenching with hill type sal is promising as plants have responded readily, and the cost of the operations is probably low enough to make the method an economic proposition on a large scale.

The successful investigations reported last year from Bengal in the regeneration of *Dipterocarpus turbinatus* by notching the seeds under high shade after removal of the ground cover, have passed the preliminary stages and are now being taken up on a larger divisional scale. Results from experiments in obtaining natural regeneration in climatic climax evergreen forests in Chittagong indicate that the best results are obtained by gradual opening of the canopy from below upwards, as was found in the Federated Malay States. A large amount of data was collected from experimental garden and nursery experiments for many local and exotic species. Pre-monsoon teak stump planting was proved to be preferable to planting in the rains and also preferable to direct sowing or entire transplanting, as, owing to the rapid growth of the stumps, it is possible to save at least one year's cleanings in the plantations. The retention of suppressed and dominated stems of sal when thinning was found to reduce the incidence of harmful climbers considerably. Investigations into the technique of raising mixed plantations continue and should yield useful results in a few years. In the All-India teak seed origin experiments plants of Nilambur origin did best, then the local Kaptai origin, which was almost equal to the Burma origins. The Bombay origins were the least successful.

Bombay has no separate post of Silviculturist, the work being carried out by divisional forest officers under the control of the Chief Conservator. Early burning was proved to be detrimental to sandalwood natural regeneration. Stump planting of *Terminalia chebula* gave more promise than either direct sowing or entire transplanting. Indications were obtained that the thinning out of coppice shoots in teak, leaving only one shoot per stool, is desirable.

In Burma stump planting experiments with teak indicate a preference for stumps of over $\frac{1}{2}'$ diameter, $\frac{3}{4}''$ diameter being the optimum, though larger sizes up to $1\frac{1}{4}''$ gave good results. 6" to 8" root and 2" stem were found to be the most suitable. The best time for planting (contrary to results in Bengal, Madras, Bombay, Coorg and Dehra Dun but agreeing with results elsewhere in the United Provinces) was found to be at the break of the rains, which gave better growth and survivals than pre-monsoon planting, direct sowing or entire transplanting. The variation of results from different parts of India is probably due to the occurrence or absence in different localities of occasional showers before the actual break of the rains. Crow-bar hole planting is now found to be cheaper and more efficient than other methods of planting (confirming results from other provinces). Weathering teak seed by alternate soaking (for 12 hours) and drying (48 hours) repeated 6 to 8 times just before sowing gave earlier and more regular germination. In connection with stump analysis investigations it was found that the taper of teak trees does not alter appreciably during the life of the tree, the relation between girth at breast height and that at different levels remaining fairly constant for different G. B. H. classes in any one division.

In the Central Provinces, natural regeneration of teak is found to spread gradually into areas successfully protected against fire and grazing. In the All-India teak seed origin plots Nilambur and Mysore origins have shown much greater growth than other origins, but local origin shows the best form. Investigations have been started to determine the desirability or otherwise of thinning out multiple shoots of teak and sal coppice.

In Coorg a small research branch with a special research ranger has been started and is working in conjunction with the Madras Silviculturist. Investigations are chiefly concerned with the artificial regeneration of sandal, teak *taungya* work and the regeneration of tropical evergreen rain-forests.

In Madras useful systematic research on planting technique for teak continues to be done. The advantages of pre-monsoon stump planting, previously reported, have received further valuable confirmation in an exceptionally dry season. The very considerable retarding effect of some *taungya* crops on the growth of teak has been demonstrated, but it has been shown that this can be partly overcome by early stump planting. Storage of teak stumps up to three weeks, and their transport to distant places, have been proved feasible. It was again confirmed that in naturally light friable soil aeration in teak plantations by forking confers no advantage over cheaper weeding methods.

Contrary to some results from other parts of India it was again shown that sorting out of teak seed (fruits) by size is not justified, the

germination and subsequent growth from large fruits being not appreciably better than from small. Further valuable confirmatory work on the best thickness, length of root, method of planting, etc., of stumps of teak and other important species was done.

Intensive research into the best methods and species to use for regenerating dry fuel forests was carried out and some definite recommendations can now be made as a result of these investigations. The feasibility of stump-planting sandal has again been shown.

The retarding effect of weeds in a teak plantation was very strikingly demonstrated, an increase of 165 per cent. in growth being obtained in 2 years in a clean weeded plot as compared with divisional weeding practice.

Extensive investigations into the best methods of regenerating tropical evergreen forests have been continued and some useful results obtained. A beginning in systematic research into thinning methods has been made with 27 plots at Nilambur and further sets are being laid out in Wynaad division.

Spike disease research in sandal also now comes within the sphere of the silviculturist's activities, the most noteworthy result of the year being the successful experimental transmission of the disease on several occasions by insect vectors. The main problems that are being dealt with in this connection are the control of spike by removal of sources of masked infection, the isolation and breeding of resistant varieties of sandal, and the determination of immunising species of host plants with a view to their introduction in sandal bearing areas to reduce the incidence, and the isolation of the insect vectors of the disease with a view to their ultimate control.

Further experiments in the North-West Frontier Province have confirmed that successful natural regeneration of *Pinus excelsa* forests is chiefly dependent on reduction in the depths of the unfavourable "A"—horizon of the soil. Winter stump planting of walnut was again found to be the most certain method of regenerating it and stumps of ash were also successful. Large cuttings of willow and poplar 3½' long gave better results than smaller cuttings. Closure to grazing has been found to produce conditions unsuitable for natural regeneration in *Pinus longifolia* and *Pinus excelsa* forests.

In the Punjab the Director of the Irrigation Research Institute has, in collaboration with the Silviculturist, collected and worked up data on soil profiles in deodar, silver fir, spruce and *Pinus excelsa* forests, which will shortly be published. Work has been concentrated on nursery technique including seed weighment, storage, pre-treatment, germination methods and post seedling behaviour of the more important species used for planting, and gave interesting results. Studies on suscepti-

bility to frost damage were made, and experiments in introducing exotic conifers were tried, larch being the most promising.

In the United Provinces, problems concerning the natural regeneration of sal continued to form the chief items on the research programme, and the investigations are progressing favourably. Frost is the chief difficulty. A cover crop of *Tephrosia candida* at Haldwani protected sal seedlings in *taungya* from a severe frost though the *Tephrosia* itself was killed by it. Introduction of sandal, using Madras and Coorg seed, has been again tried in lantana areas, and a leaflet was published giving interim results of investigations on reclamation of *usar* (saline) soils. Extensive resin tapping investigations continue, indications in favour of deep tapping being obtained. A series of forest leaflets for local circulation has been started for the publication of interim results on experiments in progress, chiefly to keep the territorial staff in touch with the research branch with a view to make use of even tentative results;—an idea that might be followed in some other provinces with advantage, especially where long-term investigations are in progress or where useful preliminary results are obtained requiring verification by repetition of the experiments.

In the sphere of forest utilization the appointment of a Forest Utilization Officer in Assam has been approved. This is a step in the right direction.

The experiment of the use of *ping* (*Cynometra polyandra*) as a substitute for hickory for vibratory screens in the Assam Oil Company's wells at Digboi continues to show promising results. This Company is also experimenting with the use of *hollong* (*Dipterocarpus macrocarpus*) as a substitute for imported red cedar. A regular market has been established for *champa* (*Michelia champaca*) in Calcutta.

In Bengal, *sundri* (*Heritiera minor*) was supplied to the Shevades Camera Works, Belgaum, and to the Presidency Jail, Alipore, to test suitability for their work. Bamboos were also under test for suitability for tool handles. A supply of *saur* (*Betula* spp.) was tried by the Gramophone Co., Dum Dum, and some orders for this timber were placed by the Company. A large variety of species were sent to Controller of Stores, E. B. Railway, to test for tool handles.

Bihar and Orissa have continued, with considerable success, their efforts to find new markets for their forest produce. New markets were found for packing case timber in Calcutta, hardwood sleepers in the Dhanbad Coal Field, for poles in the coal fields and the Indian Copper Corporation, and for *salai* (*Boswellia serrata*) for kegs with the Indian Wire Products, Ltd., Tatanagar. Various tests on tool handles and timber suitable for pencil making are also in progress. The question of floating sal and other poles and also bamboos is being investigated.

The Burma report contains much interesting material. The chief activities of the year may be summarised as follows :—

(*a*) Further study of the damage to teak timber by the beehole borer moth (*Xyleutes*) by milling sample batches of plantation teak logs from 10 divisions and by data collected by teak lessees in their Rangoon mills on the number of beeholes in natural teak squares.

(*b*) Arranging for supply and passing of 10,000 B. G. *pyinkado* (*Xylia dolabriformis*) sleepers to the Northern Group Sleeper Pool, Lahore.

(*c*) Collection of statistics in connection with the sale of Burma timbers in export markets.

(*d*) Further work on Teak Grading in liaison with the teak lessees and Forest Economist, Dehra Dun.

(*e*) Preparation of a series of notes and articles on Burma timbers, with special reference to competition by substitutes, grading, etc.

(*f*) Working out a scheme in conjunction with the Customs for the collection of statistics of timber Imports and Exports with a view to establishment of a Central Clearing House in India for supply of information to the trade.

(*g*) Investigation of the effect on the new match duties under the India Act—1934 on Match wood supplies.

(*h*) Study of variations in the quality of teak wood.

(*i*) Answering miscellaneous questions on Burma timbers, lac, cutch, *tung* oil, bamboos and other minor forest produce.

The revised edition of Rodger's Hand-book of the Forest Products of Burma was sent to press during the year.

In the Central Provinces, owing to adverse climatic conditions, there was a large drop in the yield of lac, 1,250 mds. as compared with 2,862 mds. in 1933-34. Prices continued to rise until July after which they fell considerably. The demand for the gum of *Sterculia urens* (gum *karaya*) continued to improve. During the year 59,291 cwts. of the gum were exported to foreign markets.

In Madras a further contract for two years has been made with the S. I. Railway for the supply of special sized teak sleepers. A three year contract for the supply of hardwood sleepers has also been made. Teak and other hardwoods were also taken by the railways for carriage and wagon work, and teak logs supplied to the Public Works Department and Jail Department. The market for timbers showed no sign of improvement, the best demand being for teak. Work on the developing of markets for lac and shellac continued. A total quantity of 11,541 lbs. of grain lac and dust lac was disposed of during the year.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

ASSAM.

I.—Experimental Silviculture.

(i) *General.*

The post of the Silviculturist remained vacant throughout the year but Mr. A. Das, I.F.S., carried on the duties so far as possible in addition to his work on the preparation of the Flora of Assam up to the 7th August 1934, when he was succeeded by Mr. C. S. Purkayastha, P.F.S. The work on the Assam Flora consists principally, for the time being, in getting the results achieved to date through the press, and it is hoped that the Botanical Officer will be able to organize the Silvicultural research work on proper lines.

(ii) *Natural regeneration including coppicing, root suckers, etc.*

(*a*) *From seed. Evergreen Forests.*— Results of subsidiary operations, including the felling of lower canopy trees in places in recently worked over coupes of Lakhimpur and Sibsagar, have been most encouraging. Measurements in Indicator and Control Plots, laid out in a coupe of the Disai Reserve, show that height increments of *Dipterocarpus macrocarpus* (*hollong*) and *Mesua ferrea* (*nahor*), in one year, are 14·61 ± 1·77 inches and 3·3 ± 1·02 inches respectively in the Indicator Plots compared to 4·33 ± 3·97 inches and 0·88 ± 0·80 inches in the Control Plots. There was no appreciable seedling recruitment as a result of the subsidiary operations.

Measurement of Indicator Plots in the Experimental Plots of Joypore shows that, given annual tending, *Dipterocarpus macrocarpus* (*hollong*) responds better than *Mesua ferrea* (*nahor*) under an open condition of canopy.

It is worth mentioning that seedlings of other comparatively infrequent, but important, components such as *Magnoliaceæ* (*sopa*), *Artocarpus chaplasha* (*sam*), etc., are few in number and stunted in growth under a close canopy, whereas advance growth of such species in more open localities have increased in height by about 15 to 20 feet in 5 years in the Indicator Plots.

Dipterocarpus turbinatus (*gurjan*) and *Eugenia jambolana* (*jam*).— Several Experiments have been carried out by successive Divisional Forest Officers of the Sylhet division to establish natural regeneration

of these species round their mother trees by making clearances and systematic weeding. The records show that complete stocking can be obtained in 4 or 5 years over ·04 acre of *jam* and 1·5 acre of *gurjan* from a single mother tree. These results are not likely to be useful in practice, as the distribution of such valuable trees in the type of forest where they occur is so sporadic that it will be impossible to ensure subsequent maintenance of such scattered patches of regeneration established at considerable expense and trouble.

Terminalia myriocarpa (*hollock*).—Several experiments have been done in the Sadiya division to determine the wind direction at the time of seed fall and the range of seed dispersal as a result of which a system of aided natural regeneration has been evolved. Based on these data the system prescribed in the Working Plan consists of keeping rows of mother trees at right angles to the wind direction (*i.e.*, about east-west) at intervals of 8 chains and clearfelling the rest of the area.

Shorea robusta (*sal*).—Very considerable progress has been made in Kamrup in achieving sal natural regeneration in patches, though not always in the compartments where it was particularly wanted. The problem of inducing whippy shoots to pass into the fleshy stage at a pace sufficient to allow of the desired exploitation of the standing trees is principally the one requiring solution.

Mr. De, Divisional Forest Officer, Goalpara, has an experiment in the Bamba Block (Bahbar zone) to study the invasion of *Imperata* (*thatch*) in a *Pollinia* (*sau*) area. Where there was some *thatch* before, it is extending gradually, but where it was initially absent *thatch* has not come in yet though the area is being burnt annually for the last few years.

The *Eupatorium-invasion* of Goalpara continues and its line of attack is along the sides of roads and paths.

(*b*) *From coppice and root suckers.*—Nil.

(iii) *Seeds (collection, weight, germination per cent, plant per cent, aids to germination, etc.).*

The Divisional Forest Officer, Nowgong, reports that germination of *Cassia fistula* is hastened by soaking the seed in boiling water for 5 minutes. The next best treatment is to dip the seeds for 48 hours in a mixture of cow-dung and water.

Muli bamboos (*Melocanna bambusoides*) have been noticed in fruit in the Raghunandan Reserve, Sylhet division.

(iv) *Nursery work.*

An experiment was started in 1931 in the Holongapur Reserve (Sibsagar division) with a view to ascertain (1) the best time of sowing for

maximum germination, and (2) the effect of the size of mother trees on germination and plant per cent. for a number of species that occur in the Evergreen forests of Upper Assam. Observations have been made for one year only and the following results require confirmation by subsequent observations for a number of years more.

Amoora wallichii (*amari*).—Germination per cent. increases with the size of mother trees, germination being about 91 per cent. in the case of the specimen tree 7'-5" in girth. Casualties in one year in most cases were about 2·5 per cent.

Nyssa sessiliflora (*gahorisopa*).—Germination is best in the case of specimen trees of 6'-7' girth class, being about 51 per cent. Germination continues for more than a year.

Michelia montana (*titasopa*).—Germination is very low and the size of the mother tree has apparently no effect. Seeds were not treated before sowing, which may account for poor germination.

Talauma phellocarpa (*korika sopa*).—Germination per cent. is generally poor but improves with the size of the mother trees,—being about 22 per cent. for a mother tree 6'-1" in girth. Seeds were not treated before sowing.

Mesua ferrea (*nahor*).—Germination per cent. of 3'-4' girth class trees appears to be the best, being 36 per cent., though differences are not very great.

(v) *Artificial regeneration, including taungya.*

The Divisional Forest Officer, Goalpara, is experimenting on restocking of grass land with *simul* (*Bombax malabaricum*). One year old transplants, with roots pruned to 6" and shoots intact, are put out. If the leading shoots do not dry up in the 1st year of planting, it is expected that, in the 2nd year, the plants will grow above the grass when the *simul* can be considered as established. Normal root system is re-established in one year. In the Nowgong division a new method is being experimented for the propagation of *simul*, by breaking up the soil below seed-bearers which is supplemented by broadcasting the seed over the area.

In the Goalpara division, transplanting of 9 months old entire plants of *Michelia champaca* is recorded to have given very satisfactory results.

Pure plantation of *Gmelina arborea* (*gamari*) in Sylhet division has been abandoned because the species requires very heavy thinning from early years with a view to maintain the height growth and a well developed crown which is necessary to fight the attack of *Loranthus scurrula*. This leaves too few stems for the final yield to make pure *gamari*

plantations economically useful. The present policy is to grow *Artocarpus chaplasha* and *Dipterocarpus turbinatus* in intimate mixture with *gamari*. In early stages these species are not affected by the light shade of *Gmelina*, whereas in subsequent years heavy thinning of *gamari* will meet the light requirement of these species.

In the cinchona plantation of 1933 (K. & J. Hills) the present height of the plantation, now one year old, is about 3'.

(vii) *Tending.*

Thinnings, cleanings, climber and weeds. Upper Assam Evergreen type.—The Working plans of Sadiya and Lakhimpur have tentatively laid down that thinning of *Terminalia myriocarpa* plantations should be done in the 2nd, 4th, 6th and 10th year and afterwards every 10th year. The matter awaits systematic research.

Surma valley Gmelina plantation—A plantation scheme has been sanctioned for the Sylhet division, which prescribes that with a spacing of 12'×9' the first thinning cannot be delayed longer than 5 years. It has been observed that if thinning is delayed longer, the conical shape of the crown is lost and once this stage has been reached no thinning would produce any visible response afterwards.

Sal.—In the Nowgong division, where *Eupatorium* is the principal weed in *sal* plantations, an experiment is being carried out to work out the comparative cost of raising plantations with different spacings. It is expected that very close spacing will ensure early closing up of the canopy and the extra cost may be compensated for by the saving in cutting down the *Eupatorium*, which, with wide spacing, has to be continued for a very long period (8-9 years).

(viii) *Mixtures.*

No systematic work has been done yet but the general instructions for this year are to obtain a mixed crop wherever possible, mixture being arranged in pure patches of small size (about 2½-5 acres). The only exception is in the case of *Gmelina* where other species are tried in intimate mixture with it for reasons given under (v).

(ix) *Under-planting.*

No systematic work has been done under this item.

(x) *Silvicultural system.*

Unless there is a reasonably high proportion of valuable species in the natural forests, and natural regeneration can be assured, the Silvicultural system that has been prescribed in the Sadiya Plan and is likely

to be prescribed in future for other such mixed forests of Assam consists of,

(1) felling of valuable trees above a certain girth limit consistent with a policy of sustained yield, and

(2) artificial regeneration of a specially selected blank area, most convenient from the point of view of labour supply and future exploitation, so as to produce the equivalent volume annually removed from the whole forest under (1).

(xi) *Miscellaneous.*

1. A systematic survey of the *Gmelina* plantation (about 5 *sq.* miles) in Sylhet division was made which shows that *Loranthus* attack is confined to—

(1) About 6 per cent. of the total area.

(2) Areas along both sides of openings such as Railway lines, rivers and roads.

(3) Closely planted areas with a spacing of 6′×6′ or 6′×9′,—areas with a spacing of 12′×9′ being comparatively free.

(4) Plantations more than 5 years old.

2. A further consignment of samples of cinchona bark was sent during the year to the Government Quinologist, Bengal, from the Mikir Hills plantation of 1929-30. Results of the analysis are given below :—

——	Root.	Stem.	Branch.
	Percentage.		
Quinine	3·15	3·07	1·60
Cinchonidine	0·40	0·60	0·10
Quinidine	0·15	0·00	0·00
Cinchonine	0·48	0·47	0·38
Amorphous	·05	·83	·37
Total alkaloids . .	5·43	4·97	2·51

Samples were from dying trees and better results are expected when the plantation will be clearfelled next year.

II.—Working plans and statistics.

(i) *Working Plans.*

Mr. C. Purkayastha, P.F.S., continued to act as Working Plans Officer up to the 7th August 1934, when he was succeeded by Mr. K. B.

Mohanlal, I.F.S. The post of the second Working Plans Officer remained vacant during the year.

Working Plans of the Plains Reserves of Lakhimpur and Sadiya divisions are now in the press.

The field work for the Working Plan of the Nowgong division, including the *bonsum* (*Phœbe goalparensis*) bearing reserves of the Sibsagar division, was completed during the year.

(ii) *Yield Volume and Form Factor Tables.*

The Assam Forest Records (Silviculture), Vol. II, with the title "Provisional Volume Table and Rates of Growth for few important species in the Mixed forests of Upper Assam" was compiled by Mr. C. Purkayastha, P.F.S., and sent to the press. It has since been published.

Sample Plots.

There were 14 Sample Plots under the Silviculturist's control at the beginning of the year; remeasurements of 3 plots were done according to prescriptions. 3 Sample Plots of K. & J. Hills were added during the year.

BENGAL.

I.—Experimental Silvicultube.

(i) *General.*

Mr. C. K. Homfray, Deputy Conservator of Forests, was in charge of the Division throughout the year. He and the Conservator of Forests attended the 4th Silvicultural Conference at Dehra Dun in October 1934, and then visited the *sal* forests of Gorakhpur (U. P.), to collect information on the management of *sal* coppice and the method of raising *sal* plantations there.

All divisions except the Sundarbans were toured by the Silviculturist. Mr. C. G. Trevor, C.I.E., Inspector General of Forests, toured Northern Bengal in April 1934 and Mr. Champion, the Central Silviculturist, toured the hill plantations of Darjeeling and Kurseong and inspected the Silvicultural experiments (including nurseries at Takdah and Sukna). The Forest Botanist (Mr. Parkinson) toured Southern Bengal during November and December 1934, in the Chittagong and Chittagong Hill Tracts divisions. He gave invaluable help in the identification of trees in the Linear Sample Plots laid out at Mainimukh, Chittagong Hill Tracts division, and at Bhomariaghona, Chittagong division.

These visits have been helpful and are greatly appreciated. The Inspector General of Forests made several useful suggestions for future silvicultural experiments which are gradually being taken up as staff and funds permit. Work was carried out in both Southern and Northern ranges in accordance with the programme.

(ii) *Natural Regeneration.*

(*a*) *Dipterocarpus species.*—Experiments in natural and natural-*cum*-artificial regeneration of *gurjan* (*Dipterocarpus turbinatus* and *Dipterocarpus costatus*) were continued in the Chittagong and Cox's Bazar divisions. The methods that have been tried up to date are as follows :—

(i) Annual burning with and without removal of the understorey; also with and without soil working.

(ii) Broadcasting with and without hoeing.

(iii) *Notching* deep and light.

With both *Dipterocarpus costatus* and *Dipterocarpus turbinatus* annual burning with and without the removal of the understorey has not so far resulted in the appearance of natural regeneration. The evergreen undergrowth however is being gradually replaced by *thatch* grass. A little amount of natural regeneration was induced by hoeing before seed fall but the growth was too slow and the condition of the seedlings too delicate to enable them to cope with even low weeds.

The success of *notching* seeds of *Dipterocarpus turbinatus* under high shade is very encouraging and far superior to that of broadcasting with or without hoeing. The cost of establishing plants under experimental conditions works out at about Rs. 20 per acre and has taken about 4 years. Under actual conditions it can probably be done for much less. It has now been decided that this experiment has passed the experimental Stage I, and will be carried out in Stage II by the Divisional Forest Officer, Chittagong, on a larger scale in certain fuel coupes. The fuel removed as a lower storey is saleable and the canopy which consists of the biggest and best timber can be removed at any time that a market is found after the new crop has been established. As the result of past experiments instructions for *notching* have been laid down as follows :—

1. *Initial condition.*—Forests are usually 3-storeyed, with scattered trees in the top storey, a fairly dense middle storey, and dense undergrowth consisting of bamboos and annuals and perennials.

2. *Details of work to be carried out* :—

(i) All undergrowth should be cut in the cold weather.

(ii) What is required is an *evenly balanced high canopy*, and low shade is definitely harmful. To obtain this all good timber species in the top

canopy should be retained, and the only species in the 2nd storey to be retained are those that are required to keep an even canopy. The remainder of the species in the 2nd storey should be removed. It must be clearly understood that where there is shade given from two layers of canopy, the lower storey must be removed, leaving only the upper storey.

(iii) The areas should be burnt between the end of March and the beginning of April, care being taken to protect the standards from fire, by scraping the slash away from the base of the standards. The success of this method depends a lot on a good burn, and burning must be carried out before April storms start.

(iv) Seeds of *Dipterocarpus turbinatus* are collected as soon as ripe, and must be carefully sorted out by hand, any seeds on which a spot of gum is found are rejected. Seeds are then "*notched in*" as soon as possible after collection making a hole with the point of a *dao*, placing the seed in the hole—½" to ¾" deep, and then just covering up with earth. Seeds should be "notched in" about 3 feet apart, coolies working together in lines.

(v) An intensive cleaning is required during August of the first year.

(vi) In the cold weather all that is required is the pulling up of climbers and *assam-lota* (*Eupatorium odoratum*) in the month of November before it starts flowering. No undergrowth is to be cut unless actually interfering with the plants.

(vii) After the first year, cleanings should be done in the rains as required. In the cold weather all scattered *assam-lota* should be pulled up in November until plants are out of danger. Climber cutting should be done when necessary. It must be clearly understood that thorough cleanings are not required, and they must be confined to the removal of inferior species actually interfering with the growth of the individual *gurjan* plants.

(viii) *Fire protection* is absolutely essential, and if the area is burnt the young plants will not recover.

Constant failure has been experienced with "notching in" of *Dipterocarpus costatus* which ripens some time before the break of the rains. An experiment was made to study comparative results of 'light' notching (¾" below surface) *versus* 'deep' (1½" below surface). The results were the same, 10 per cent. in each case. The experiment will be repeated again this year.

(*b*) *Evergreen forests.*—As described in the last year's report, the Experimental Plots, laid out in Chittagong Hill Tracts, to discover a method of raising the existing suppressed natural regeneration, were maintained.

The canopy is viewed as of four tiers counting from the top, the fourth tier being the undergrowth. By "removal" is meant the

removal of unimportant species only and does not include the useful species.

The Central Silviculturist's suggestions regarding different cultural operations were carried out and 'Indicator Plots' for selective counts of natural regeneration in squares were maintained.

The following are some of the tentative conclusions arrived at to-date :—

1. In the untreated control growth of seedlings is extremely slow (to almost *nil* during the last four years).

2. Wholesale removal of trees or heavy opening of all storeys at the initial stage is definitely injurious as it encourages rapid growth of weeds which smother existing seedlings.

3. Cutting of all undergrowth (fourth tier) and removal of part of third are essential preliminaries to any regeneration operations, as low shade retards the growth of seedlings much more than high shade.

4. Progressive lightening of the canopy of the third and second tiers is important.

5. Burning after cutting the undergrowth and removal of the third tier in the hope of getting a more uniform recruitment of seedlings has not been attended with success.

6. *Weeding and cleaning.*—It is absolutely necessary to free the existing regeneration from interfering weeds and climbers. Observations indicate that weeding must precede any real opening up of the canopy. Cleanings after the opening up of the canopy have a decided beneficial effect in the growth of the young regeneration. The best time to do cleaning appears to be May just before the rains.

(*c*) *Hopea odorata.*—As has been reported in the past the plants in the open plot are much more vigorous than those in the shaded plot and have an average height of 4'-6" in the open as against 2'-8" under shade. The average height growth during the last growing season alone was 9" in the open as against 4" only under shade. The open plot however has required intensive weeding, while the plot under shade is virtually weed free.

Results show that the natural regeneration of *Hopea odorata* benefits greatly from complete removal of overhead cover but must be weeded until such time as they close up and are fully established.

(*d*) *Shorea robusta.*—E. P. No. 16 of Buxa division, situated near the foot of the hills, was laid out to discover if, by opening up the canopy by the removal of all species except *sal* and burning the undergrowth annually, it would be possible to obtain natural regeneration of *sal* on the slopes from mother trees which are confined to the ridges and spurs. The undergrowth consisted mainly of *sau* grass (*Pollinia ciliata*)

extremely dense. As a result of 4 years' burning an undergrowth of mixed herbs and shrubs has come up thinning out the *sau*.

Recruitment of *sal* has so far been slow and poor, and although it has increased very slightly, none have reached the 'carroty' stage and can be called established. On the other hand regeneration of fire resisting species of the dry mixed type has come in in abundance.

(*e*) In the Buxa division, the experiments on burning annually the *sau* grass (*Pollinia ciliata*) areas in the Bhabar Tract with a view to obtaining natural regeneration of *sal* were continued. The area has been burnt continually for 5 years.

Sau grass is gradually being replaced in many places by *Leea crispa*, *thatch* (*Imperata arundinacea*), *Mucuna pruriens* and *Anthistiria gigantea*. There has been no marked increase of *sal* regeneration in areas of pure *sau* *Sal* regeneration is definitely on the increase in places where the soil has been exposed by the invasion of *widely scattered Leea crispa* and also in areas where *thatch* (*Imperata arundinacea*) forms the principal undergrowth.

(*f*) A small scale experiment was laid out in *sau* grass areas to see if hoeing (strips 3' wide and 6' apart) would assist in obtaining natural regeneration of *sal*. In the following cold weather it was found that there was just as much natural regeneration in the *sau* grass in the interspaces as in the hoed up strips.

(ii) An experiment was also tried to introduce sal in areas containing no mother trees and where the canopy consisted of miscellaneous species. Strips were hoed up as above and sal seed was broadcasted in the strips. Results were good.

(iii) *Seed.*

(*a*) Seeds of exotic species for experimental purposes and seed for plantations were supplied to divisions through the Silvicultural division.

(*b*) Seeds of valuable timber species for experimenting with in the plains and hills were received from Kenya, Queensland, Russia, Curator, Royal Botanic Garden, Edinburgh, and through the Forest Botanist, Dehra Dun.

(iv) *Nursery Work.*

Three nurseries and gardens are maintained by the Silvicultural Branch. The routine tests are nursery beds with and without shade, and comparison between direct line sowing, transplanting and stumps. These are repeated as far as possible for four years running so as to obtain average results. In addition at Sukna and Hazarikhil, *bogamedeloa* (*Tephrosia candida*) is sown in between the lines over half the area in May. Lines are so run as to keep the beds of direct sowing,

transplanting and stump planting partly in the open and partly under the shade of *bogamedelon*, so as to compare the relative rate of growth of each species with and without shade. All possible data regarding weight, treatment, germination, etc., of seeds are recorded for all species put out in the nurseries. The information obtained is of immense value to this Province, which depends so largely on artificial regeneration.

(*a*) In the Hazarikhil (Chittagong) nursery, observations continued to be taken on species sown since 1931. The following species were tried during the year under report :—

Dehaasia cuneata, Eugenia grandis, Dipterocarpus tuberculatus, Mesua ferrea,—all with excellent results (over 75 to 95 per cent germination)—*Swietenia macrophylla* and *Syzygium jambolanum* good (over 50 to 75 per cent germination)—*Podocarpus neriifolia* and *Bambusa tulda*—fair (over 25 to 50 per cent) and *Dipterocarpus costatus, Pterocarpus dalbergioides Anisoptera glabra, Taraktogenos kurzii, Melocanna bambusoides* and *Bombax anceps*—poor (below 25 per cent germination). *Dendrocalamus longispathus*—failed completely.

Results of transplanting of 2 to 2½ months old entire plants from the nursery to the garden were quite good (about 75 per cent over survival) for *Eugenia grandis, Dipterocarpus tuberculatus, Dipterocarpus costatus, Anisoptera glabra* and *Bambusa tulda* and fairly good (about 50 per cent and over survival) for *Swietenia macrophylla* and *Adina cordifolia*. Germination and survival percentage are both higher in the open in the case of *Swietenia macrophylla, D. tuberculatus, Dipterocarpus costatus* and *Pterocarpus dalbergioides ;* whereas *Eugenia grandis, Mesua ferrea* and *Adina cordifolia* seem to prefer the shade of *boga. Anisoptera glabra* and *Bambusa tulda* do not show any difference between open and shaded conditions.

(*b*) At Sukna, in the Kurseong division, nursery experiments were tried with species, both indigenous and exotic, suitable for the plains and foot-hills of Northern Bengal. Germination was completed between 2 to 8 months, unshaded beds giving better germination than the shaded ones practically in all cases except *Pterocarpus marsupium*. On the whole germination was good (over 75 per cent) in the case of *P. marsupium, Litsæa panamonja* and *Sterculia alata*, fair (50 to 75 per cent) for *Polyalthia simiarum* and *Saccopetalum longiflorum*, moderate (25 to 50 per cent) for *Canarium euphyllum, Lophopetalum fimbriatum, Phœbe hainesiana, Swietenia macrophylla, Dalbergia latifolia, Hymenodictyon excelsum, Ailanthus grandis, Podocarpus neriifolia* and *Albizzia marginata* and poor (below 25 per cent) for *Morus laevigata, M. indica, Sterculia campanulata, Phœbe attenuata, Trewia nudiflora, Polyalthia longifolia* and *Michelia montana. Adina cordifolia* scarcely germinated at all.

The following results have so far been obtained from the Garden experiments during the last 2 years :—

Sterculia campanulata.—Direct sowing was poor, ball transplanting and winter planting under shade and stump planting were quite good.

S. alata.—Winter planting was the best, ball transplanting and stump planting next and quite good, direct sowing fairly good too,—all in the open.

Adina cordifolia.—Direct sowing failed, winter planting in the open or shade, and stump planting were all equally very successful.

Polyalthia simarum.—Winter planting and ball transplanting in the open or shade were very successful, direct sowing moderately so in shade and poor in the open and stem planting was not much of a success.

Trewia nudiflora.—Stump planting was the best, ball transplanting next and quite good, direct sowing also good and winter transplanting moderate,—all in the open.

Litsaa panamonja.—Ball transplanting and stump planting were the most successful, next winter planting which was also good, but direct sowing was attended with poor results,—all in the open.

Saccopetalum longiflorum.—Winter planting was better than ball transplanting, direct sowing failed,—all in the open.

Lophopetalum fimbriatum.—Ball transplanting and winter planting both gave excellent results, but direct sowing practically failed to come up,—all in the open.

Polyalthia lognifolia.—Winter planting gave the best results, ball transplanting next and good results too, but direct sowing showed very poor germination,—all in the open.

Phabe hainesiana.—Ball transplanting and winter planting in shade were both very successful, stump planting next, but direct sowing in the open failed completely.

Albizzia marginata.—Ball transplanting was the best, stump planting next, direct sowing was only partially successful,—all in the open.

Ailanthus grandis, Hymenodictyan excelsum and Swietenia macrophylla.—Ball transplanting and winter planting were very successful, while results of direct sowing were poor,—all in the open.

Dalbergia latifolia.—Winter planting was the best, ball transplanting next, stump planting fairly good too, but direct sowing was very bad,—all in the open.

Canarium cuphyllum.—Winter planting was the best, ball transplanting next, direct sowing poor,—all in the open.

Morus lævigata.—Winter planting was very much more successful than direct sowing which gave poor results,—both in shade.

Morus indica.—Winter planting gave excellent results, while direct sowing very moderate,—both in shade.

Pterocarpus marsupium.—Ball transplanting and winter planting were very successful, direct sowing fair,—all in the open.

(c) Forty exotic species (from different parts of the world) were tried in the Silvicultural Nursery and Garden at Takdah, Darjeeling division, to discover valuable timber species suitable for growing at elevations between 5,000′ and 9,000′ with a rainfall of 90″ to 200″ where really valuable indigenous species are very rare. All species are tried in shaded beds of the nursery. Germination was only moderate (25 to 40 per cent) in the case of *Hovenia dulcis, Cupressus torulosa, Cupressus funebris* and *Meliosma thomsonii* and poor (below 25 per cent) for *Cupressus cashmeriana, Juniperus procera, Juniperus virginiana, Picea orientalis, Pinus sylvatica, Michelia lanuginosa, Crataegus azoroby, Eucalyptus cinerea, Pterocarpa caucasica, Staphylea colchica, Fraxinus syriaca, Sequoia sempervirens, Chamaecyparis lawsoniana, Zelkova kealki, Sequoia gigantea* and *Betula cylindrostachys.*

Germination period varied from 3 to 58 weeks.

The following species were tried in the Silvicultural Garden and in the 1935 Lingding Plantations, Darjeeling division, at an elevation of 5,900′. *Cupressus torulosa* and *funebris* continue to do very well, especially *torulosa* whose growth is faster than *Cryptomeria japonica.*

Pinus thunburgii (Japan), put out when 9″ high as ball plants in August, show few casualties, and good growth,—average height 1′-2″.

Pinus excelsa (U. P.). Casualties were few, growth good—3 year old plants 3 feet high.

Experimental cold weather planting in January of the following species were tried with success:—*Michelia excelsa, Cedrela febrifuga, Cryptomeria japonica, Bucklandia populnea* and *Hovenia dulcis.* Plants had been kept in the nursery for two rains with the exception of *Hovenia dulcis* which had only been in for one rains. Results for *Hovenia* showed that it is an extremely hardy plant and seedlings from 3″ to 3′ can be easily and successfully put out with both as rains and winter transplants.

Betula alnoides var. *acuminata.* (Seeds February-March):—Experiments tried to find out the best time for planting this species indicated that the beginning of August of the first rains when plants are about 2″ high is the best time for planting.

Betula alnoides, seeding June-July, are extremely hardy and can be put out equally well both as 2-year, old nursery plants 2′ and over in height in the rains or as six month old winter transplants. Small scale experiments gave over 95 per cent survivals in each case.

(v) Artificial Regeneration.

(*a*) Regular plantations in the Chittagong division.—

Garden Plot No. 17 was laid out in 1932 to study the rate of mortality of *Dipterocarpus turbinatus* seedlings, in a regular plantation with *bogamedeloa* (*Tephrosia candida*). The mortality up to date is just over 50 per cent, being most severe in the first and second hot weathers.

Garden Plots Nos. 15 and 16 (*Eugenia grandis* in the open and under shade of *bogamedeloa*) were laid out in 1932, with the object of ascertaining whether a shade crop is necessary to raise this species in plantations. Results show that although some amount of shade was beneficial in the first hot weather shade is harmful after the second year.

Garden Plots No. 18A and B (*Hopea odorata* in the open and under the shade of *bogamedeloa*) were laid out in 1932 with the same object as above for *Eugenia*. The percentage of survivals was slightly higher under shade in the first two years, but in the third year plants in the open were more healthy and vigorous than those under shade. It appeared that shade was not beneficial after the second year.

(*b*) *Bamboo experiments* (at Baraiyadhala, Chittagong division) were carried out to introduce indigenous bamboos, *viz.*, *muli* (*Melocanna bambusoides*) and *mitenga* (*Bambusa tulda*), under the shade of an open deciduous forest on the dry western slopes with a shallow sandy soil. In E. P. No. 17, the canopy was thinned, undergrowth cut and burnt, and *muli* and *mitenga* rhizomes were stuck 12′×12′ during the rains in 1933. Both had taken passably well, but *muli* was found to be doing poorly compared to *mitenga* in the 1st year. After the rains of 1934, however, the *muli* is looking far healthier than the *mitenga*.

In December 1933, the Central Silviculturist suggested that it would be preferable not to clear and burn but to limit interference of the canopy to climber cutting and thinning of occasional extra heavy low canopy. This was given effect to in a new Experimental Plot (No. 18) in May 1934. In this plot, direct sowings of *orah* (*Dendrocalamus longispathus*), *mitenga*, *muli* and *Bambusa polymorpha* (Burma seeds) were tried, and rhizomes of *muli* and *mitenga* were stuck, 8′×8′ apart, in the rains.

It was found that direct sowings of *muli* and *mitenga* would ordinarily be a failure, for the *muli* seeds are eaten by animals, and the small seeds of *mitenga* get washed down the steep slopes in the rains. *Bambusa polymorpha* failed to germinate. Rhizome planting of *muli* and *mitenga*

however, appears to be very promising,—success during the last season being over 90 per cent.

(c) *Teak-stump planting.*—An experiment was laid out at Kaptai (Chittagong Hill Tracts) in 1934 to find out the most suitable time for putting out stumps of teak (*Tectona grandis*). One year old stumps were put out at fortnightly intervals commencing on the 11th April and finishing 9th July. Progressive heights of plants were taken at intervals and the following was the result up to December 1934 :—

Stumps planted on	April.		May.		June.		July, 9th.
	11th.	24th.	10th.	23rd.	9th.	25th.	
Average height on 20th July 1934.	2′—0″	2′—3″	1′—0″	0′—6″	0′—5½″	0′—3½″	Just sprouting.
Average height on 10th September 1934.	4′—6″	4′—6″	3′ -8″	2′ —9″	1′—9″	0′—10″	0′—8″
Average height on December 1934.	6′—10″	7′—3″	4′—8″	3′—11″	1′—10″	1′—3″	1′—1″
Maximum height on December 1934.	9′—3″	11′—0″	6′—3″	6′—0″	3′—0″	3′—2″	1′—6″
Rainfall during the corresponding fortnight.	0·73″	3·62″	2·32″	0·13″	9·06″	11·38″	10·22″

In December 1934, the average height of teak plants, from direct sowing in 1934 plantation, was 1′—1″ and the maximum height 2′—6″ to 3′—0″. *Results show that pre-monsoon stump planting is preferable to rains planting*, and that it should be done as early as possible in April-May immediately after a good shower of rain. Numerically also there were 100 per cent survivals from the April planting and that the number decreased gradually until those of June gave only 60 per cent and July under 30 per cent. This experiment also proves that pre-monsoon stump planting is preferable to direct sowing or transplanting for if an average rate of growth of 7′ can be obtained in the first year it should certainly be possible to save at least one year's cleanings.

(d) *Sal plantations.*—Experiments, carried out in Jalpaiguri, to see if, by either burning the *thatch* (*Imperata arundinacea*) and coppicing the sal, or burning, coppicing, hoeing between the lines, and rains weeding, it would be possible to establish the sal. Results of two years show that :—

(1) By burning the *thatch* and coppicing the sal only, the *thatch* becomes more luxuriant each year and the sal still remains in the whippy stage.

(2) By burning, coppicing, hoeing between the lines and rains weeding the sal can be established in one year from a poor whippy shoot 10″ to 4′ high to a thick carroty stem 5′ to 6′—6″ in height.

(3) Where the stocking of sal is good, cover crops or rains weeding does not appear necessary in the second rains. In poorly stocked areas, however, it would appear that the use of a cover crop or rains weeding is necessary in the second rains.

(*e*) *Shoot-cuttings of Morus indica.*—Experiments were carried out in the Jalpaiguri division, with cuttings of branches 1′ long and ½″ to 1″ diameter. They were slantingly planted after the break of the rains, 10″ below and 2″ above ground. Placing of cowdung on the top of the shoots to prevent drying up does not appear necessary as the percentage of survivals has been just as good without. Results have been excellent with very few casualties, average height being 5′ to 8′ with a maximum of 12′ at the end of one rains. Rate of growth is much faster than that of direct sowing or planting and this would appear the most satisfactory way to raise this species.

(*f*) *Fuel taungyas.*—Experimental sowings of fuel species were carried out in the Kalimpong division, both in 6′ apart lines, and also in 6′ wide strips, 20′ apart. Species used were :—*Mallata* (*Macaranga* spp.) *siltimur* (*Litsaea citrata*), *lampate* (*Duabanga sonneratioides*), *pitali* (*Trewia nudiflora*), *mainakath* (*Tetrameles nudiflora*), *siris* (*Acacia and Albizzia* spp.). Germination was good and results very encouraging.

(*g*) *Cover crops in plantations.*—Experiments to find out species suitable for cover crops (against weed growth) in sal plantations, were continued with the following species at Sukna, and in other places of Kurseong, Jalpaiguri and Buxa divisions. These were mostly mentioned in the last year's report :—

Clerodendron infortunatum was tried on a divisional scale, looked promising for the first two years, then found to be dying out in the third year and becoming very thin. It does not appear to be able to suppress *thatch* grass.

Napier grass would make an excellent cover crop in areas where fodder is saleable.

Cassia tora tried on a divisional scale this year, was not successful. Although germination is good it does not appear to give sufficient shade to keep down either *thatch* grass or the quick growing weeds.

Leucaena glauca.—Much better results have been obtained with the use of inoculated soil, but it cannot be said that the growth has been really satisfactory up to date.

Tephrosia purpurea was tried for the first time this year and results look very promising. It does not grow as fast or as tall as *Tephrosia candida* (*bogamedeloa*) but was just as successful in keeping down weeds and climbers. It would not appear to require cutting back as has to be done annually with *bogamedeloa.*

Leea crispa germinated well and grew to a height of 1 ft. after which it died back in February. It started to sprout again in May and is now about 1'—6" in June forming a good cover over the ground.

Adhatoda vasica by cuttings, 9" long and ¼" in diameter, were planted 1 ft. apart in between the lines of a 2-year old *sal* plantation in the 1st week of June, but growth was slow and most of the cuttings had been killed by suppression from weeds.

In the Chittagong Hill Tracts division *Artocarpus chaplasha* in its younger stage being somewhat deciduous (this habit apparently altering with age) cleanings became expensive. Experiments were, therefore, started to introduce a crop to cover the ground, and the following were attempted:—

(1) *Lagerstroemia flos-reginae*, quincunx planting.

(2) *Castor oil.*

(3) *Eugenia* spp., quincunx planting.

(4) *Bambusa tulda*, quincunx planting.

No. (1) is showing good results and provides an excellent cover. (2) Castor oil. Such plants as exist are doing well and forming a suitable cover. (3) is also satisfactory but inferior to No. 1, and (4) very satisfactory.

(*h*) Experiments with artificial regeneration of different species hitherto untried were continued in the Kalimpong division.

Angare (*Phoebe attenuata*), a shade bearer, was tried in between lines of *bogamedeloa*. Before the second rains the area was divided up into 5 plots and *boga* treated differently to ascertain what treatment of *bogamedeloa* would render the best help to the *angare*. *Bogamedeloa* was not touched in one, it was cut back to the ground in another, it was cut back to 4 ft. from the ground in the 3rd, only its side branches were lopped in the 4th, and *boga* was thinned leaving stems 6 ft. apart in the last. The best result was obtained from the last treatment, the next best in the 4th, and there was practically no growth in the 1st and the 2nd.

(ii) *Lepchapat* (*Polyalthia simiarum*) and *dude lampate* (*Litsaea panamonja*) were tried as pure crops; germination was fair but both species suffered greatly from exposure.

(*f*) Artificial regeneration of sal without cultivators at Raimatong and Buxa Road in the Bhabar Tract, Buxa division.

Experiments laid out in 1933, detailed in last year's report, were continued and further plots in the light of the first year's experience were laid out. The object is to find out the best and most economic method of artificially regenerating sal and other important species in areas where labour is difficult to obtain.

In the *sau* (*Pollinia ciliata*) grass area, *results of second year* show that, (1) *bogamedeloa* obviously helps to keep down the *sau* grass and climbers

both in between the lines and in the sal lines themselves (Plots 1*a*, 1*b*, 2*a* and 2*b*), (2) if *bogamedeloa* is used as a cover crop the sal must be sown in 3 ft. wide bands, because if sown in 1 ft. wide bands the *bogamedeloa* is very liable to overtop and suppress the sal. In Plots 1 and 2 put out with 3 ft. wide bands of sal the centre lines of the sal were free and plants vigorous, whereas in Plot 4, where the sal was put out in 1′ wide lines only, the *bogamedeloa* was found to be suppressing the sal. Also from past experiments it is known that if the *bogamedeloa* is coppiced after the rains, the *sau* grass will suppress it. Therefore it appears essential to sow sal in 3′ bands when using *bogamedeloa* as a cover crop; (3) in plots where *bogamedeloa* was used and sal sown in 3′ wide bands there was very little difference between the growth of sal in the plots that were rains-weeded (Plots 1b and 2b) and in those in which rains weeding was not done (Plots 1a and 2a). Although the growth of sal in the rains-weeded plots was slightly better the difference was so small as to be discounted. Results indicate therefore that when *bogamedeloa* is used rains weeding is not necessary, and (4) if rains weeding is done there is no need to use a cover crop (Plot 3b) but if no rains weeding is done and no cover crop is used the sal is suppressed and plants killed out (Plot 3a).

A new plot (IV) was laid out in 1935 in *sau* grass in which cover crops were put out in the first year at the same time as the sal in order to compare results with Plot I in which cover crops were put out in the second year only.

In the *thatch* grass area (*Imperata arundinacea*), laid out in 1933, the original lay-out was exactly the same as that of the *sau* grass area.

Result in second year shows that (1) in plots where no rains weeding was done and no cover crop used *thatch* came up in abundance and killed out the sal in the second year in spite of the roots being hoed up and burnt in the first year, and (2) if suitable cover crops are used rains weeding is not necessary and cleaning in the cold weather will suffice.

In the *Evergreen area* started in 1933, the lay out was exactly the same as the *sau* or *thatch* area. *Cassia tora* was used as a cover crop in Plots 1a, 1b, and 4, cotton in Plot 2a and 2b, and no cover crop was used in plots 3a and 3b. *Assam-lota* (*Eupatorium odoratum*) came in abundance all over the area and suppressed the cover crops mentioned above causing a large expenditure in cleaning and making a comparison between the different treatment in the plots difficult. Sal in all plots suffered from suppression.

Results with teak (*Tectona grandis*) and *panisaj* (*Terminalia myriocarpa*) are extremely promising. The cost of establishing them is much less than sal, that of teak being less than *panisaj*. In addition neither

require fencing as is the case with sal. The *panisaj* had formed a canopy after the first year and no *assam-lota* came in ; with teak *assam-lota* had to be sickled back once only during the rains.

(vi) *Reclamation and Afforestation.*

Results on experimental *taungya* and regular plantations of sal and *kanthal* (*Artocarpus integrifolia*), made in the Dacca-Mymensingh division, in order to afforest blanks, are reported to be successful.

(vii) *Thinning and Cleaning.*

(*a*) While touring in the divisions the Silviculturist made several sample thinnings in plantations to give the Range Staff an idea of the intensity of thinnings required in each case.

(*b*) Experiments were carried out, on a divisional scale, to see if the incidence of climbers in sal plantations could be reduced by leaving the suppressed and dominated stems in thinnings. Ocular estimates indicate that in most cases there were less climbers in areas where the suppressed and dominated stems had been removed and a "D" grade (heavy) thinning done.

(*c*) Experiments with different grades of thinnings in *panisaj* (*Terminalia myriocarpa*) to see if heavy thinning encouraged growth of climbers showed that after two years there were less climbers in the heaviest thinned (D grade) plot and most in the unthinned plot.

(*d*) Experiments were continued to discover the best method of eradicating climbers in plantations. It will take a few years before it will be possible to draw any satisfactory conclusions. An experiment carried out in the Jalpaiguri division demonstrates the benefits of digging up climbers in plantations.

(*e*) The climber *gurja* (*Tinospora cordifolia*) is the most harmful climber in plantations. Once it has got into the crowns of the trees it lives epiphytically and can no longer be eradicated and is responsible for most of the malformed sal. Affected areas are now being coppiced and burnt, and any new shoots of *gurja* appearing above ground are dug up. Results of such operations have been extremely successful.

(*f*) Experiments on controlled burning in sal plantations were continued.

Soil samples were taken from both the burnt area and the unburnt control, at levels of 0″-9″, 9″-18″ and 18″-27″, and sent for physio-chemical analysis.

(viii) *Mixtures in Plantations.*

Experiments with different methods of mixing have been continued on an extensive scale in most divisions. The following are the more

important methods tried during the year, both in Northern and Southern Bengal.

(*a*) Mixed line sowing of *panisaj* (*Terminalia myriocarpa*) and *chikrase* (*Chickrassia tabularis*), *panisaj* and *toon* (*Cedrela microcarpa*), *mandane* (*Acrocarpus fraxinifolius*) and *chikrase*, *gamari* (*Gmelina arborea*) and *toon*, the object being to raise a second storey to cover the ground in plantations where light demanders constitute the principal crop which will become very open after the first thinning.

(*b*) *Alternating groups of lines* (*strips*) *of several species.* The method is simple in practice and is chiefly used when putting out different species of approximately the same rate of growth. 5 lines for the faster growing and 7 for the slower would appear to ensure a mixture in the final crop.

(*c*) *Group planting of several species, individual groups being 12'×12'.* This method requires a great deal of expert supervision at the time of planting, and although mixtures under this method have been put out very successfully, the alternating groups of lines method gives nearly as good a mixture and is far simpler.

(*d*) *Alternate line mixtures* is most suitable for mixing fast-growing light-demanders and slow-growing shade-bearers. In Chittagong Hill Tracts, experiments on such mixtures have now been tried for several years and show definite promise. The outstanding success has been *gamari* (*Gmelina arborea*) with *tali* (*Dichopsis polyantha*), and *gamari* with *gurjan* (*Dipterocarpus turbinatus*).

Mahogany (*Swietenia macrophylla*) in alternate lines with *gamari* has not been so successful.

Alternate lines of *panisaj* (*Terminalia myriocarpa*) and *angare* (*Phoebe attenuata*) in the plains of Northern Bengal, and *utis* (*Alnus nepalensis*) and *fusre champ* (*Michelia lanuginosa*) in the Hills also show distinct promise.

(ix) *Underplanting.*

In the Chittagong division, *gamari* (*Gmelina arborea*) was put out extensively (between 1923 and 1927) on unsuitable areas and although it started well, it began to thin out soon owing to attacks by *Loranthus* (*Loranthus scurrula*). There were only two courses open to reclaim such areas,—whether it would be cheaper and more effective to replant them or to make use of the light and fairly high canopy by underplanting suitable species. With this end in view some experiments were made from 1930-32 to try the effect of line sowings of *gurjan* (*Dipterocarpus turbinatus*) and *tali* (*Dichopsis polyantha*) in between the lines of *gamari*. Results with both these species look very promising, and will now be tried as a Stage II Experiment on a larger divisional scale.

(xi) *Miscellaneous.*

(*a*) *Co-operative investigation on the origin of teak* seed.—The second series of these experiments were undertaken in 1933 and the following tabular statement gives the growth of seedlings of the different origins and their mortality per cent :—

Particulars.	Bengal.	Bombay.		Burma.		Madras.
	Kaptai.	E. D. Kanara.	W. Khandesh.	Tharrawaddy.	Myitkyina.	Nilambur.
	E. P. No. 39 —(Actual counting and measurement of all plants)					
Mortality per cent end of 1st season, December 1933.	11	15	10	9	7	7
Additional mortality per cent, end of 2nd season, December 1934.	6 } 17	23 } 38	19 } 29	8 } 17	8 } 15	6 } 13
Average height, end of 1st season, December 1933.	0'—7"	0'—3½"	0'—3"	0'—6½"	0'—6"	0'—8"
Average height, end of 2nd season, December 1934.	5'—2"	2'—11"	2'—1"	5'—6"	4'—5"	5'—5"
Increase in height during 2nd year.	4'—7"	2'—7½"	2'—1"	4'—11½"	3'—11"	4'—9"
	E. P. Nos. 33 to 38 —(Counting and measurement of 10 per cent of plants of each origin.)					
Mortality per cent, end of 1st season, December 1933.	5	10	10	5	20	5
Average height, beginning of 2nd season, June 1934.	2'—6"	2'—10"	1'—0"	1'—0"	1'—6"	2'—0"
Average height, end of 2nd season, December 1934.	5'—0"	4'—5"	1'—10"	6'—8"	5'—7"	5'—11"
Average growth during 2nd season.	2'—6"	1'—5"	3'—4"	2'—8"	1'—1"	3'—11"

From measurements as well as from general observations it seems evident that the two Bombay origins (E. D. Kanara and W. Khandesh) have fared the worst. Their mortality, in both first and second years, is the highest and their growth the slowest. Also in the first year their seeds took far longer to germinate than those of other origins. As regards the other four origins (Kaptai, Tharrawaddy, Myitkyina and Nilambur) there is not much difference between them ; Nilambur has done the best,—even better than the local Kaptai origin.

(*b*) *Rot in root and shoot-cuttings of teak.*— The use of stumps is established and the possibility of resultant rot is under systematic study. The Forest Mycologist, Dehra Dun, examined specimens of growing plants and reports that none of the specimens sent show any definite signs of rot that could be considered detrimental to the plants.

(*c*) *Bambusa tulda and Melocanna bambusoides.—Experimental Plots* laid out at Inoni, Cox's Bazar, to discover the best rotation for cutting and to study the effects of cleaning, are being maintained. As the Inoni plots represent a relatively poor quality of bamboo, another set of plots

(E. P. No. 20A-E) was laid out in a better quality area this year in the Ramgarh-Sitakund range, Chittagong division.

(*d*) *Soil Samples.*—Dr. J. C. Ghosh, D.Sc., Head of the Department of Chemistry, Dacca University, has very kindly consented to carry out physio-chemical analyses on forest soils sent to him. It was decided to investigate the reasons as to why young sal regeneration appears in some parts of our forest and not in others. Samples of soils from 9 different sal forests have been sent to him during the year.

(*e*) *Preservation plots.*—27 plots covering the more important forest types in the Province are being maintained.

(*f*) *Urostylis punctigera* in *champ* (*Michelia champaca*).—The pest continues to do considerable damage to young *champ* plantations. The Forest Entomologist, Dehra Dun, is investigating its life-history and trying to find control measures.

II. Working Plans and Statistics.

(i) *Working Plans.*

(*a*) The Revised Working Plans for the Sundarbans and Kurseong divisions were received from the Press and published during the year.

(*b*) The Revised Working Plan for the Kalimpong division is in the Press.

(*c*) The Revised Working Plans of the Chittagong division and Cox's Bazar sub-division were under compilation during the year.

(ii) *Yield Tables.*

The Province now maintains 197 permanent Sample Plots, 20 Diameter Increment Plots, 18 Linear Sample Plots, 88 Experimental Plots, 7 Garden and Temporary Plots and 27 Preservation Plots distributed over all divisions. Out of this total of 357 Plots, 19 are new. Observations or remeasurements have been made in 127 Plots, as became due, during the year under report. One new Linear Sample Plot was laid out in Preservation Plot No. 24 in the Tropical Evergreen Forests at Mainimukh, Chittagong Hill Tracts division.

Ring counting and Stem analyses.—Stem analyses of 43 trees of 25 different species were carried out during the year.

Measurement of sap-wood and heart-wood.—Measurements of sap-wood and heart-wood for all the more important species of 4′ girth and over (at 4′—6″) felled in coupes were carried out in all divisions by the divisional staff, and results sent to the Silviculturist for record.

III.—Miscellaneous.

(*a*) *Ledger Filing.*—Ledger filing of all important extracts was carried out as before. There are now 177 Specific and 135 General Ledger files in the office.

(*b*) Records of all measurements of Sample and Diameter Increment Plots were sent to Dehra Dun for compilation of volume figures, and all observations made in Experimental and Garden Plots were recorded.

(*c*) More photographs were added during the year. There are at present 458 photographs of silvicultural importance in the Provincial collection.

The active co-operation of local officers and the help given by the Forest Research Institute and other Provinces are gratefully acknowledged.

BIHAR AND ORISSA.

1.—Experimental Silviculture.

(i) *General.*

The work of re-organising the Research division, begun during 1933-34, was continued during the year under review. Mr. F.C. Osmaston, I.F.S., was in charge throughout the year assisted by a Ranger, attached to the Silvicultural branch, and another Ranger to the Utilisation branch.

The Forest Research Officer and the Silvicultural Ranger toured all the divisions of the Chota Nagpur group.

The Forest Research Officer attended the 4th Silvicultural Conference at Dehra Dun from the 29th October to the 3rd November. The New Forest nurseries were visited and the Institute's methods of tackling silvicultural problems studied. Excursions to the Dehra Dun and Saharanpur divisions were also arranged. As a result, Silvicultural Experimental Plots of a new type were laid out, as well as some Sample Plots and one Preservation Plot.

All the Experimental Plot records of territorial divisions were checked and brought up to date. About three dozen photographs were taken during the year by the Forest Research Officer. Research work is being done according to the Triennial Research programme.

(ii) *Natural Regeneration.*

Thirteen Experimental Plots and one Preservation Plot, the first of its kind in this Province, were laid out during the year. Objects in six of these Plots, Nos. 33-36 of Saranda, and Nos. 27 and 28 of Kolhan, are to discover if heavy seeding fellings, followed by rains-cleanings every year, with or without periodical burning, will induce sal (*Shorea robusta*)

regeneration. Two Plots (Nos. 22 and 23, Kolhan) were laid out to study the effect of raising the water level and of irrigation upon the growth of dry Q IV sal forest and regeneration.

Three Plots, Nos. 24-26 Kolhan, are to examine the causes of the drop in the annual yield of *sabai* (*Pollinidium angustifolium*) grass, if and how far the practice of annual burning is responsible and whether fire protection and manuring will both be necessary to maintain or increase the yield. Plot No. 5, Palamau, is to discover whether coppicing or pollarding at a height of 2′ or 4′ will give better results in the management of katha (*Acacia catechu*).

Plot No. 6 Palamau (*Dendrocalamus strictus*) sets out to discover the best felling cycle and the correct intensity of felling, out of several under consideration.

Nineteen Experimental Plots were abandoned during the year. No conclusions could be drawn from Experimental Plots No. 4 and 9, on "burning" in Saranda (in damp type sal forest), as the plots being close to a road, sawmill and camping ground, cattle had grazed and undergrowth and saplings had been cut.

Similar Experimental Plots on "burning," Nos. 11-14 Saranda, in dry grassy type sal forests, showed that fire protection encouraged the establishment of sal regeneration while annual burning definitely hindered it. In Experimental Plots 11-15 Porahat, the object was to discover whether burning and cutting back whippy sal (*Shorea robusta*) advance growth improved subsequent development in open dry Q IV sal forest. Observational results show that the production of multiple shoots from each stump is encouraged by burning and (less so) by cutting back. Burning in dry forest is definitely harmful (causing a setback to height growth), while cutting back would appear to be unnecessary if not definitely harmful.

In Experimental Plots Nos. 16-18 Kolhan, the object was to discover whether burning for five years, previous to felling in large and small groups, followed by fire protection would result in encouraging growth of the existing sal regeneration unhampered by weeds and climbers. In one plot where the prescriptions were strictly followed, sal regeneration grew up very well indeed. In five years, saplings increased by 128 per cent while unestablished regeneration increased from nothing to 44. Mortality in the established regeneration was only 2 per cent, in spite of the very large number (78) which moved up into the sapling stage. The total increase of saplings in nine years was 135 or 220 per cent, or 41 per cent, since felling was made in the 5th year, while the unestablished regeneration had increased to 500 plants. These results are remarkable and show that annual burning is not necessary in moderately damp sal forest.

Experimental Plot No. 44 of Puri division, in the *Casuarina* (*Casuarina equisetifolia*) plantation shows that the death of trees cannot be attributed to the water level in the plantation as there was no significant variation in water level within or without the affected area.

In Experimental Plots 47 and 48 of the same plantation the growth of trees in areas water logged from July to October was compared with those growing in a drier locality. It was found that in dry localities growth ceased from February to July, commencing again 2-3 weeks after the rains began. On the other hand in wet localities, growth only ceased during the months of October-November and December. In 2 years, the total growth was faster (5·75 ft.) in water logged areas as compared with 3·7 ft. in dry areas. Growth was fastest in dry areas during September and October, and in wet areas during August, September and October. *Casuarina torulosa* failed completely in the *Casuarina* plantation, owing to bad initial germination.

In the *Porahat* division, the *Loranthus* infected sal poles were practically in the same condition as they had been in 1933, and the Divisional Forest Officer is of opinion that *Loranthus* does not necessarily shorten the life of the pole.

An experiment has been initiated by the Conservator of Forests to study the effects on bamboo clumps of the removal of all mature culms except those of the year and of the previous year. Observations appear to indicate that bamboo culms commence to die back from the tip after four or five years.

In the *Puri* division, the natural regeneration of sal in the Southern range continues to give trouble. The Divisional Forest Officer thinks that " continual burning over a long period is the only way to bring about healthy conditions for regeneration. Sal seeds are known to germinate profusely whenever a good seed bed has been prepared by burning and clearing, but tending operations are required for a long period to get them fully established. The aim now is to eradicate the mass of evergreen undergrowth which springs up over the seedling growth in the rains, damping off any seedlings which appear ".

Burning.—Two Experimental Plots were laid out by the Divisional Forest Officer, Angul, to study the effect of fire on (1) an area already full of regeneration and (2) an area without any. The plots were burnt rather severely and as might be expected all the established regeneration of 3'—4' in height died back. In the second plot sal seedlings germinated but died back later. Early burning, to mitigate the damage done by late intensive fires, was successfully carried out in the bamboo areas of Tainsi and Chotamunda, in order to clear the ground of felling debris. No damage was, however, done to the bamboo clumps. The practice will be extended next year to a much bigger area.

Bamboo selection fellings.—Selection fellings of bamboos, as worked by Messrs. Heilgers, though satisfactory from the Silvicultural point of view, are reported to have certain disadvantages, namely :—

(1) The new or one year old clumps do not appear to grow up straight.

(2) The culms are susceptible to wind damage and are easily blown down.

(3) Elephants find it easier to tackle the clumps and cause greater damage. It will be interesting to see if, in later years, the clumps recover from these defects.

(iii) *Seed Collection.*

The Puri division supplies large quantities of teak seed from old teak areas of Barunai Felling Series and the germination percentage is reported to be very good.

(iv) *Nursery Work.*

Mortality in Angul among seedlings, pricked out in April and May, from sowings made in March was 85 per cent. Such high mortality results were also experienced in Kolhan. The best results are obtained from seeds sown late in April or early in May, whose seedlings are ready for pricking out by the end of June. They can then be transplanted, 9″×9″ into the beds just vacated by the nursery stock of root and shoot cuttings of the previous year. Such continuous cropping of the nursery soil requires heavy application of manure in the form of leaf mould rotted debris from the cleanings of P. B. I. areas or *sabai* grass refuse. Soil from camping grounds is good as it contains a large amount of wood ash and animal excreta.

In the Palamau division, the best pretreatment to the teak seed was found to be the "alternate soaking and drying" in which case germination took only 20 days.

Several experiments were tried at the Hinoo Nursery with some species of different origins and with different objects. These are summarised below :—

Germination tests were carried out with *Pterocarpus marsupium* (maximum germination was 47 per cent of the Chaibassa seed), *Terminalia tomentosa* (26 per cent germination with pretreatment) and *Acacia catechu* (64 per cent). In the case of teak, germination percentage was not affected by the quantity of manure applied, transplanting in the hot weather resulted in heavy mortality (but not so in the rains) and post-monsoon cold weather stumping failed completely.

(v) *Artificial regeneration including Taungya.*

Stage II Sabai.—(Pollinidium angustifolium).—Experimental Plots, 13 and 20 Kolhan, have proved the possibility of economically cultivating *sabai* grass (*Pollinidium angustifolium*) as a commercial crop, as reported last year. The plots are now to be used to investigate the effects of burning, fire protection and manuring. Annual weeding is essential, and occasional uprooting to prevent weed establishment, beneficial. Opinion is divided as to whether annual burning in May is beneficial or harmful. Planting closer than 3′×3′ does not give a heavier yield. *Sabai* rootstocks must be planted out in rainy weather and not during a dry spell. The divisional plantation shows a profit of Rs. 102 this year upon an upkeep expenditure of Rs. 708-10-3 giving 7·5 per cent return on formation costs representing the capital invested.

In Porahat, fire line planting of *sabai* is reported to be expensive, which is attributed to the heavy cost of uprooting the prolific regrowth, and it has been suggested that only portions of fire lines selected as comparatively free from undergrowth should be planted up. Otherwise planting may not be economically successful.

Experimental sowings of teak and bamboos were made over 3 acres in the Sambalpur East division and in Sambalpur West. The teak plantation at Ramedega was slightly extended.

Contour trenches were dug in Lhora, and sal, *bija* and teak seeds were sown. About 80 per cent germination resulted (except teak which germinated only 5 per cent), yet all died at the end of the year. Evidently sowings in the forest are not successful in this division and other methods of raising plants must be relied upon.

Kodarma does not appear to be a suitable place for growing teak and *Dolichandrone platycalyx*, the latter being all killed by white ants while the teak survivals do not look healthy. Experiments with stump planting teak at different dates showed that May 24th was too early, better results being obtained by planting on 17th June.

In Kolhan, experience in the plantation suggests that the species teak, *piasal*, *Dalbergia latifolia* and *Swietenia macrophylla* would do better as root and shoot cuttings, and arrangements have been made accordingly to raise them. It is considered advisable to concentrate on the propagation of indigenous furniture woods such as *piasal* (*Pterocarpus marsupium*) rosewood and *bandhan* (*Ougenia dalbergioides*) which are popular locally rather than put down too large an area under teak, which is an exotic.

In Puri, some success was obtained with the following miscellaneous species put out in the *casuarina* plantation:—

Albizzia lebbek (50 per cent), *Eucalyptus rostrata* (30 per cent), *Melaleuca leucadendron* (60 per cent), *Eugenia jambolana* (30

per cent), *Careya arborea* (30 per cent), cocoanut (75 per cent), *Calophyllum inophyllum* (70 per cent), and *Dalbergia latifolia* (90 per cent). The low percentage in some cases is attributed to prolonged draught.

In Palamau experimental planting of exotic bamboos was a failure. Assam bamboo culms and Trinidad culms were used. Country bamboos are looking unhealthy ;—of 17 acres of Kechki Block, six were sown with seeds, six were planted up with one and two year old natural seedlings and five acres were planted up with offsets from healthy one year old culms, yet only 15 per cent of each kind were surviving in October 1934. Failure is attributed to attacks by white ants, squirrels and rats.

(vi) *Reclamation and Afforestation including Irrigated Plantation.*

Chaibassa.—Experiments in connection with the filling up of blanks in Protected Forests show that sowing in lines, after ploughing, is preferable from the ryots point of view as this allows grass in between the lines to be cut more easily. From the forest point of view, broad-cast sowing gives a better distribution, better soil covering, is easier and the growth of spear grass is less. Early sowing gives better results than late and the greater the quantity of seed used within season the better the results. Sowings in mixture with *boga* is recommended and the rate of growth is faster where the run-off of water during the rains is slower. Consequently contour trenching is being experimented with. The following species were tried :—Teak, rosewood, *Albizzia lebbek* and *A, odoratissima, khair*, bamboo, *Kigelia pinnata, kongra* (*Xylia xylocarpa*), *Duabanga* (from Bengal). *Chickrassia, Pterocarpus santalinus, Pithecolobium dulce, Cassia siamea, Acacia moniliformis* and *Hardwickia binata.*

Results are encouraging, considering the hard nature of the barren soil.

(vii) *Miscellaneous including fire, grazing.*

Water control.

Irrigation of Q IV Sal.—The experiment with Hill Type sal was continued in Kolhan division. Altogether 2,600 running ft. of contour trenching has been done at a cost of Rs. 520 to date, covering an estimated area of 13½ acres, and the response of plants has been appreciable. Moribund regeneration has sprung to life and its growth compares very favourably with that of Q I area. Besides, this scheme carried out on a fairly large scale will have a considerable effect on minimising flood damage to the general community.

Regeneration of simul (*Bombax malabaricum*) and *bhurkund* (*Hymenodictyon excelsum*).

Towards the close of the year, experiments were made in the Kolhan and Porahat divisions to increase the amount of *simul* and *bhurkund* regeneration in valley areas. Fan shaped openings were made on the lee-side of mother trees extending to a distance of 100 yards or more. Seed is also being sown at stakes in areas where seed bearers are few.

II.—Working Plans and Statistics.

(i) *Yield, Volume, and Form factor Tables.*

There were 131 Standard Sample Plots previously. By converting certain thinning Experimental Plots and laying out some new plots the total number of Sample Plots is now 192.

Data for outturn tables have been collected in the Kolhan division and the work of compilation is nearing completion.

Khair pollarding experiments are being carried out in Palamau to estimate the outturn of kath.

BOMBAY.

I.—Experimental Silviculture.

(i) *General.*

Under the direct control of the Chief Conservator's office there were 11 subjects under investigation during the year while problems of purely local interest were taken up for investigation by the Divisional Forest Officers concerned under the general control of their Conservators.

The work done and observations made are briefly described below :—

(ii) *Natural Regeneration.*

Sandal (*Santalum album*).—*Subject No. 28.*—Effect of early burning on the growth and regeneration of sandalwood.

The two plots (mentioned last year), 28 A—rigidly fire-protected and 28 B—early burnt every year—are still under observation in Belgaum since 1933,—the object being to confirm the results obtained in the original experiment.

The original measurements of trees in these plots in this second investigation were taken in December 1933 and the 1st remeasurement in December 1934.

Measurements at the end of one year only cannot give any definite conclusion, but they indicate that there is no significant difference in the average height, while, in the average girth, plot A shows an increase of ·57″ over that of plot B. The Divisional Forest Officer, Belgaum,

remarks that the regeneration in Plot A is more profuse than in Plot B, but in view of the fact that late fires cause extensive damage to plantations early burning perhaps does more than compensate for the difference in the intensity of regeneration.

(v) *Artificial Regeneration.*

Rosha grass (*Cymbopogon martini*).—*Subject No. 12.*—Artificial propagation of *Rosha* grass (West Khandesh division).

In the belief that *rosha* requires 3 years to establish itself, this plantation was ordered to be kept under observation for a period of 3 years from 1932. The Divisional Forest Officer reports, however, that there has been no progress in the spread of *rosha* grass in this plantation and he estimates the present stocking at 9¼ annas. He is of opinion that the grass requires to be cut back annually to encourage its further spread, a theory requiring proof.

Hirda (*Terminalia chebula*).—*Subject No. 13.*—Propagation of *hirda* (Poona and Satara divisions).

Results of experiments to test whether "stump planting" of one year old nursery seedlings would be a more successful method of propagating *hirda* artificially than direct sowings or transplanting entire seedlings indicate very satisfactory results (77 per cent survival, in 2 years) in spite of severe frost in January 1935, when 104 plants are said to have been killed.

Direct sowing of seed gives a low percentage of germination, and the majority of the resultant seedlings succumb to the depredations of crabs, peafowls, squirrels, etc. The method of planting stumps cut from one year old nursery seedlings, therefore, appears to be particularly suitable for the artificial reproduction of *hirda* provided the locality is a suitable one.

In the Satara division, stumps from 2 years old nursery plants were put out in the monsoon of 1934 but the percentage of survivals at the end of January 1935 was only 38.

Sandal.—Experiment on regeneration of sandal in Block XIX by agri-*cum*-forestry system—Belgaum division, Jamboti Round.

Two plots 15 acres each in extent were laid out, one in coupe No. 1 and the other in coupe No. 2, in a thickly lantana infested area with the object of (*i*) checking the growth of the lantana, and (*ii*) raising, by means of the agri-*cum*-forestry system, valuable tree species especially sandal in the area cleared. Seeds of five species, *viz.*, *Santalum album*, *Cassia siamea*, *Pterocarpus marsupium*, *Dalbergia latifolia* and *Pongamia glabra* were sown in small patches 10 feet apart throughout the length and breadth of the plots, with *nachna*, the field crop, in the intervening spaces.

Special attention was given to the sandal regeneration as the other species were sown chiefly as host plants within easy reach of sandal seedlings. The figures of survivals given below therefore refer to sandal only. Sowing commenced on the 11th June and germination was 95 per cent. Casualties were immediately replaced and the plantation promised to be a cent per cent success till February 1935 when the abnormal long spell of hot weather killed out a good many plants reducing the survival percentage to 30 and 28 in coupes Nos. 1 and 2 respectively.

(vii) *Tending– Thinnings and Cleanings.*

Subject No. 4.—Effect of thinning on teak coppice at different ages (East Thana division).

The Divisional Forest Officer, East Thana, has made the following observations in connection with this experiment :--

(1) The growth is slower where 3 or more shoots are retained per stool than in the case of one or two shoots per stool.

(2) Where there are 3 or more shoots per stool, the dominant shoot or shoots show better growth in girth whereas the suppressed shoots have not put on any growth or in many cases are killed by suppression.

(3) Where more than two shoots per stool are retained the dominant shoots in most cases have put on 1 to 2 inches of girth-increment.

(4) Where single coppice stems or seedling plants are retained the growth observed in most cases is 2 to 3 inches in girth-increment.

The obvious deduction is therefore that unnecessary shoots should be cut down and only one shoot retained.

Subject No. 6.—Increment of babul under different degrees of thinning (Hyderabad, Sind).

During 1934-35 an additional set of 9 half-acre plots was laid down in compartments 9 and 10 of Manjhand Forest in an even-aged babul crop which was regenerated in 1930. This crop was "avenue-thinned" in 1932 (*i.e.*, about half of the crop was clear-felled in alternate strips at intervals of 33', the belts of trees being roughly 15' to 20' wide). The object of laying down these additional plots is to compare the different degrees of thinning according to the new Sind method (in which regular spacing within certain fixed limits is laid down).

The first thinning in the belts was done to the same degree, so that the initial measurements would be comparable for all plots.

(xi) *Miscellaneous.*

Sandal.—Subject No. 7.—Girth increment of Sandal (Belgaum and Dharwar-Bijapur divisions); and *Subject No. 32.*—Correlation existing between the outer girth increment and heartwood increment of sandal (Dharwar-Bijapur division):—The plots were remeasured as became due.

Bahan (*Populus euphratica*).—*Subject No. 10.*—Economic age for cutting *bahan*—Vitality of coppice stools. (Shikarpur division.)

Plot 10 C was felled in the 2nd rotation and necessary data recorded.

The yield in the form of poles has been very low in all classes. It was noticed that many stumps had not coppiced at all, due, it is believed, to the charring of the stumps which occurred when the branch wood was burnt.

Miscellaneous species.—In order to reduce the danger from fire occasioned by heavy growth of grass on old cultivation and deserted village sites in the Tansa Catchment area in Thana, where destructive fires are an annual occurrence, a preliminary experiment was undertaken to discover whether *Bauhinia racemosa* is sufficiently fire resistant to serve as a suitable species for raising a crop of trees in such open spaces to keep down the growth of grass.

A plot of one acre was selected, ploughed and sown with *Bauhinia racemosa* seed in furrows 6 feet apart, germination commenced early and, apart from weeding once during the monsoon, no further attention was given to the plot. At the end of May 1935 the survivals are estimated to be about 80 per cent, the seedling being about 6" in height.

It is proposed to repeat the experiment this year and collect actual figures relating to cost and survivals and other useful information.

Eradication of prickly pear by the introduction of cochineal insects in Badami and Bagalkot ranges was successful. The insects are reported to have naturally spread to prickly pear areas in the forest.

II.—Working Plans and Statistics.

The following working plans were sanctioned by Government during the year:—

(1) Revised working plan for Haliyal Teak Pole Forests (Blocks VII A and I to X of Kanara, N. D.).

(2) Working plan for Nagzari Valley, Kalinadi-Kaneri slopes, Kanara, N. D.

BURMA.

I.—Experimental Silviculture.

(i) *General.*

Staff.—Mr. R. W. V. Palmer, Deputy Conservator of Forests, was in charge of the Division throughout the year.

The full programme of work was carried out.

(ii) *Regeneration of Ingyin (Pentacme suavis). Project E. I.*

Considerable progress has been made particularly since 1932 in the establishment of the artificial crops sown in May 1928 in heavily worked *ingyin* forest with a dense undergrowth of *thekke* (*Imperata*).

Line sowings, sowing at stake, broadcasting and transplanting were tried. The area had been burnt over before sowing. Half the plots were regularly weeded and the other half left unweeded. In April 1929, all over-head cover was removed and all *ingyin* seed bearers in and near the plots girdled before flowering. In May 1929 blanks were patched. The plots were re-divided in 1930, half were fire-protected and half burnt.

Monthly weedings were continued in the rains of 1930, 1931 and 1932. Two cleanings were only done in May and July 1933 and none since.

The plots from line sowings were the best of the four sets.

Since 1929 the total number of seedlings has remained fairly stationary in the fire-protected and weeded or unweeded plot, has decreased steadily in the burnt and weeded plot, and increased steadily in the burnt and unweeded plot.

The changes, which are relatively small, refer mainly to un-established seedlings.

Weeded plots now show a well established crop of saplings. It was noted that the weeded plots, both burnt and protected, contained much sturdier, upright growth than the unweeded plots where plants were thin and straggly. Provided weeding and cleaning is done, fire protection appears to hasten establishment.

(iii) *Experiments with teak stumps. Project E. XII (a).*

Details of the experiment carried out in 1933 were published in last year's Report. All plots were remeasured in December 1934.

Results show that the original advantage of planting stumps at the break of rains has been maintained through the second season, and the casualties are very low. Stumps planted in mid June remain no better than transplants.

Experiments were continued in 1934, the lay-out and size of the experiment was the same as in 1933.

Two inch stem, eight inch root and $\frac{5}{8}$" to $\frac{7}{8}$" diameter were retained as the standard size as this was found suitable last year.

In addition, small experiments with standard sized stumps were put down with a different (Latin-Square) lay-out. In all experiments the current divisional practice of direct sowing at stake or transplanting nursery seedlings of the year was used as control.

From ' pre monsoon planting " the largest survival percentage was 50 but in the majority of cases mean survival heights were inferior to rains break planting but superior to late planting and to controls.

It was noticed that sprouting from early stumps was actually later than from stumps planted at the break of the rains.

With one exception (at Kyunchaung where pre-monsoon stumping gave 86 per cent survival and better height growth than early monsoon planting) the best results were obtained—as they were in 1933—from planting as soon as the rains broke or very shortly after. The superiority of these results over pre-monsoon planting and over direct sowing or transplanting from nurseries is large everywhere. This was also apparent from other instances as well.

Diameter differences were tested at Kunsan, and stumps were taken from the 1933 nurseries. Stumps of less than $\frac{4}{8}$" diameter and more than $\frac{7}{8}$" were scarce and the small diameter class consisted of 80 per cent $\frac{4}{8}$" stumps and 20 per cent $\frac{5}{8}$", the medium class consisted entirely of $\frac{6}{8}$" diameters, and the large class of 80 per cent $\frac{7}{8}$" and 20 per cent $\frac{8}{8}$" or $\frac{9}{8}$". There was clearly insufficient difference between medium and large classes to warrant analysis. The mean survival height of all three sizes was satisfactory. Later statistical analysis suggests that stumps $\frac{4}{8}$" and below are slightly inferior to $\frac{6}{8}$" stumps. Such $\frac{8}{8}$" and $\frac{9}{8}$" stumps as were used produced good results but with the present nursery practice they are unlikely to be obtainable in quantity.

Root length differences were partially tested at Nyaungbinzin as in 1933, and it appeared likely that the mean height of survivals from 10" root lengths was better than from 8" or 6" lengths. The difference has not, however, been fully analysed, because 10" root lengths are not common in one year old nurseries and are more expensive to use.

Planting with the jumper was again found quicker (and so cheaper) than the soil borer or *tooywin*. Possibly a short hardwood peg and mallet could be advantageously used by *ya*-cutters for planting stumps.

Experiments with planting standard sized one year old stumps *versus* nursery seedlings of the year (as soon as big enough) to fill up blanks in 1933 *taungyas* were made at Myohla, Nyaungbinzin and Kunsan.

Results from two years' experiments indicate a great advantage (both in survival as well as in growth) for one year old stumps if planted at the beginning of the monsoon. Strong plants with average heights up to three feet, compared with one foot from seedlings, may be expected in the first year and the advantage is retained through the second. Except in the cooler sea-board climate of Tenasserim, where the growing season probably starts a month earlier, it is unlikely that pre-monsoon planting can be used to take advantage of occasional early rains. Long hot periods with the ground and air still dry are common and kill back the exposed stems.

(iv) *Nursery experiments. Project E. X(d).*

Experiments on the treatment of teak fruit to secure early and even germination were made at several centres in 1932, 1933 and 1934. Several treatments have been tried and a moderate though not very striking measure of success obtained. In 1934, experiment was confined to the treatment which gave the most consistent results in previous years while being suitable for general use and not markedly prone to chance influences from outside. This treatment consists in repeating 6 to 8 times the alternate soaking (for 12 hours) and drying (for 48 hours) of the fruit. The commencement of the treatment, which lasts 15 to 20 days, has to be so timed that fruit is ready for sowing in nurseries or at stake as soon as the rains break. In 1934 the actual differences, though significant mathematically, were small, and the treatment was probably stopped too early (12½ days duration only). At 4 out of the 5 centres however germination of treated fruit was better than germination of controls which in each case was the current Divisional Method. Working the soil in the nursery before sowing did not usually assist early germination but improved the final germination percentage slightly. There was no clear difference between nurseries on high ground and nurseries on low ground.

A small experiment was carried out by the research staff to test differences in fertility-percentage (by cross cutting) and germination-percentage (by sowing in nurseries) of large teak fruits and of small teak fruits. Only obviously defective fruit was discarded in the sample used.

The experiment showed that large fruit is markedly more fertile than small fruit (90 *per cent* compared to 46 *per cent*) but that the germination-percentage from fertile fruits is probably about the same irrespective of size (65 per cent). There was further no difference in the robustness of seedlings up to a month old.

The experiment confirms previous opinion that, where fruit is cheap and bought by the measure, and particularly where transplanting is the practice, it is a mistake to screen out the small fruit, provided only,

apparently sound well-formed fruit is accepted, as the greater number of small fruits to the measure more than balances their lower percentage fertility.

(v) *Investigation of the influence of seed origin in the case of teak.*

Regarding the above co operative investigation, initiated by the Central Silviculturist, fresh experiments were put down at Kunsan in Zigon division (Lower Burma) where 3 half acre plots were planted in 1934-35 with Nilambur seed, Travancore seed and local seed. In addition lines of 100 seedlings of Nilambur, Travancore, Myitkyina and local seed were planted. Seed of other origins did not arrive in time for use and germination of Myitkyina seed was insufficient to give a large plot.

Combined average results from all plots up to 4 years of age are as follows —

Origin	Average height of survivals in feet and decimals to age of			
	1 year.	2 years.	3 years.	4 years.
Nilambur	1·2	5·1	13·1	19 9
Travancore	1·1	8 9	11·8	17·3
Zigon (local)	1·0	7·6	12·6	16·1
Kanara	1·3	7·3	9 8	11·6
Myitkyina	1·3	7·2	10 4	13 8
Mysore	·9	7·1	..	..

Combined average results of remeasurement of the 1931, 1932 and 1933 plots at Pinbaw are given below :—

Origin.	Average height of survivals in feet and decimals to age of			
	1 year.	2 years.	3 years.	4 years.
Nilambur	1·7	5·8	11·5	..
Travancore	1·8	6 0	12·7	13·8
Tharrawaddy	1·2	5·1	11·1	..
Kanara	·9	5·3	10·1	10·1
Myitkyina (local)	1·5	4·8	11·7	14·0

At both centres results from Kanara and Mysore origins have, to some extent, been affected by late arrival of their seeds.

II.—Working Plans and Statistics.

(i) *General.*

Five new volume increment sample plots were formed during the year for the following species:— *Gmelina arborea*, *Pentacme suavis*, and *Xylia dolabriformis*.

Sixty five of the existing sample plots were remeasured during the year.

(ii) *Volume Tables.*

Working of the data (on teak) from over 800 girdling note books, received from various divisions, has just been taken in hand.

Collection of figures for species other than teak was started towards the end of 1934.

(iii) *Diameter (and Girth) Increment.*

In (*Dipterocarpus tuberculatus*).—Measurement of diameter increment of *in* trees in Experimental Plot No. 1, Satthwa Reserve, Zigon division for a period of 8 years from February 1927 to February 1935 has shewn that the average diameter of 69 trees was 9·19″ in 1927 and 10·91″ in 1935. The average annual diameter increment of 69 trees is 0·22 inches.

Ingyin (*Pentacme suavis*).—In sample plot No. 9, Bhamo division, first measurement was made in 1929 at the age of 14 and remeasurement was done in 1934 after a period of 5 years. Average diameter of 274 trees was 3·54″ in 1929 and 4·50″ in 1934. The average annual diameter increment of 274 trees is 0·19″.

Taukkyan (*Terminalia tomentosa*).—In sample plot No. 17, in pure natural forest, Bhamo division, first measurement was taken in December 1929 and remeasurement made in March 1935 after a period of 5 years.

Average diameter of 49 trees was 14·85″ in 1929 and 15·16″ in 1935. The average annual diameter increment of 49 trees is ·06″.

Thitsi (*Melanorrhoea usitata*).—In sample plots Nos. 4 and 5 (combined), Bhamo division, first measurement was taken in November 1924 and remeasurement in January 1935.

The average annual diameter increment is ·17″.

Girth increment.—In sample plots Nos. 1, 2, 4 and 5 combined in natural forest, Mosit Reserve (old Kaukkwe), Bhamo division, first

measurement was made in 1910, and remeasurement in 1935. Abstract results are given below —

Species	No. of trees measured	Average girth in 1910 in inches.	Girth increment for a period of 25 years in inches and decimals	Average annual girth increment in inches and decimals.
Tectona grandis . .	63	52 123	22 050	0 882
Pentacme suavis	49	40 487	6 028	0 241
Terminalia tomentosa . .	47	40 080	5 360	0 214
Dipterocarpus tuberculatus	121	43·589	4 043	0 196
Dipterocarpus turbinatus .	31	43·452	11·910	0 477

Diameter increment of coppice stems of the following species, in thinned and unthinned plots, measured in Sample Plots Nos. 5, 6, 7, 8 and 9, Maymyo division, is indicated below. The plots were first measured in 1929 and remeasured in 1934 after an interval of 5 years. Ages of the crop range from 11 to 20 years .—

Species	Thinned.			Unthinned.			
	Number of stems measured.	Average diameter in 1929	Average diameter in 1934.	Average annual increment over a period of 5 years	Number of stems measured	Average diameter in 1929.	Average diameter in 1934.	Average annual increment over a period of 5 years.
Castanopsis argyrophylla	70	4 46"	5 10"	0·10"	71	3 31"	3·89"	0 12"
Castanopsis tribuloides	121	3 33"	3 80"	0 49"	83	4·16"	5·78"	0 32"
Quercus Kindleyana . .	702	3 24"	3 64"	0 08"	309	3·21"	3·30"	0 01"
Quercus polystachya	547	3 90"	4 75"	0 15"	506	3·55"	4 07"	0 10"
Quercus fenestrata . .	371	4 31"	5·37"	0 21"	428	3·88"	4 53"	0 14"
Quercus mespilifolia .	31	3 70"	4 39"	0 14"	26	2 95"	3·63"	0 14"
Quercus serrata . .	6	3·10"	1 60"	0 24"	2	3·40"	3·76"	0 08"
Schima wallichii . .	50	3 80"	5 20"	0 28"	42	4 22"	5·31"	0 22"
Albizzia odoratissima .	46	2 81"	3·40"	0 11"	23	3·40"	3 97"	0·11"
Anneslea fragrans . .	25	3 71"	4·97"	0 25"	14	3 11"	3 89"	0 16"
Craterolæa spp .	47	2 81"	3 38"	0 11"	53	2 52"	3·42"	0·12"
Lagerstræmia spp. . . .	11	3 90"	5 09"	0 23"	24	2 89"	3 46"	0 11"

(iv) *Stump analysis of Teak.*

During the year a new draft set of orders for stump analysis was drawn up and tried practically with a view to find out if they were suitable or to suggest any modifications and alterations.

The new orders have substituted girths for diameters and counts by unit of radius for the decadal count. The method briefly is as follows :—

Suitable stumps are selected and the girth measured. This is converted into radius by using the formula $\frac{G}{2\pi}$. Two radii approximating as closely as possible to the mean calculated radius are then selected and counts are made by inch units along these radii. Taper is measured by taking the girths of a large number of green trees at 4′ 6″, 1′ 6″, 12″ and 6″ from the ground. Bark thickness is measured on a number of trees.

Before this season's work was carried out it was not known whether taper varied with the size of the tree but the impression was that older trees were more buttressed than young ones and there was a tendency to assume that buttressing increased with age. The few figures for taper which had been previously collected were insufficient to give any sort of a curve and it had only been possible to draw a straight line through the points obtained.

The figures obtained this year have produced some interesting results. The first is that there appears to be no alteration in taper during the life of the tree. Further it was found that the relation between the breast height girth and that at different levels was not only reasonably constant for different breast height girth classes in any one division but remained constant for the three divisions for which figures were obtained.

Results of the season's work are given below. The rate of growth as shown by the stump radial counts under bark is plotted as an age/diameter curve which is then corrected first for bark thickness and then for taper to bring it to breast height.

Rates of growth are given below :—

[U. M. $\frac{\text{M.}}{\text{D.}}$ D.=Upper mixed $\frac{\text{moist}}{\text{dry}}$ deciduous.]

	Diameters.													
	4		8		12		16		20		24		28	
(1) *Tenmaung*—														
U. M. M. D. Yonlin and Min byin	21		41		61		79		94		117		139	years
Reserves, 71 stumps		22		16		16		19		19		22		Intervals
(2) *Meiktila*—														
U. M. M. D. Yabe and Kin mun-daung	18		38		53		67		82		100		122	years
Reserves, 69 stumps		20		15		14		15		18		22		Intervals
(3) *North Toungoo*—														
U. M. M. D. Saingzone	26		49		71		93		118		145		177	years
Reserve, 25 stumps		23		22		22		25		27		32		Intervals
(4) *Meiktila*—														
U. M. D. D. Kinmundaung and Yabe.	15		26		47		59		71		86		102	years
Reserves, 67 stumps		21		11		12		12		15		16		Intervals.

The time taken to reach 6′ 6″ and 7′ 6″ breast height girth in each case is shown below :—

——	Age to 6′ 6″.	Age to 7′ 6″.	Time taken to grow from 6′ 6″—7′ 6″.
Pyinmana	121	142	21
Meiktila U. M. M. D.	104	124	20
Toungoo	153	182	29
Meiktila U. M. D. D.	99	..	--

CENTRAL PROVINCES.

I.—Experimental Silviculture.

(i) *General.*

Systematic experiments to study the various local silvicultural problems have been taken in hand only lately. The information included under this head must, therefore, continue to be mostly of an empirical nature.

Besides the Experimental and Sample Plots under the management of the Provincial Silviculturist, there are other Experimental Plots of special local importance in several divisions, records of which are maintained by the Divisional Forest Officers.

(ii) *Natural regeneration.*

(*a*) *By Seedling. Teak.*—In South Chanda, unusually successful teak regeneration has been obtained in an area of mixed forest with a few teak in the canopy and a dense growth of bamboo and *suriya* (*Xylia xylocarpa*) in the lower storey. Teak advance growth was very scanty, suppressed under bamboos. In June 1928 the plot was clear felled, except for two seed bearers, and burnt. In May 1929, as there was little teak, many bamboos and much vigorous *suriya* coppice, the area was burnt again. In December 1934 the growth of teak is described as prolific, averaging about 1 foot in height, and the operation has been completely successful in converting a mixed forest, *cum* bamboo covering teak regeneration, into a more or less pure teak forest. Clear fellings followed by burning are now being largely practised as a result of observations in this and similar plots.

In Yeotmal, good teak regeneration was noticed in areas where the forest floor is strewn with trap boulders partly because such areas are

avoided by cattle, but also because the seed easily lodges between the crevices and thus germinates and takes root. Retention of miscellaneous species to afford shelter to the forest floor from insolation in the hot weather is also considered desirable to increase the chances of naturally regenerating teak areas

Progressive increase in the amount of seedling regeneration in the Melghat forests, is attributed to continued successful fire protection, but frost is still a serious retarding factor.

Fresh experiments to study the effect of burning slash have now been laid out and interesting results are expected by next March.

Observations of survivals of natural one year old sal seedlings in the Indicator plots, under dense, moderate and light shade of overwood, in the Bilaspur, Balaghat and Mandla divisions are expected to yield useful results in a year or two.

In the West Berar division, *anjan* (*Hardwickia binata*) is slowly being ousted by *dhaora* (*Anogeissus latifolia*) and to some extent by teak and *khair* (*Acacia catechu*), and excellent natural regeneration of *chandan* (*Santalum album*) was noticed round mother trees.

(*b*) *By coppice.*—In Nimar, clear felling of suppressed teak regeneration in essentially mixed stands, and opening up of the overwood in 1930 have resulted in excellent coppice growth. Teak is particularly vigorous but *palas* (*Butea frondosa*), *aonla* (*Emblica officinalis*), *lendia* (*Lagerstroemia parviflora*), *bael* (*Ægle marmelos*) are also growing well.

It was also noticed here (as well as in Hoshangabad) that *anjan* (*Hardwickia binata*), up to 3′ in girth, coppiced very well. Young shoots of this species are badly browsed by wild animals.

Seven years of clear fellings in the teak forests of Betul show that the system has definitely been a success. The rate of growth of resulting coppice is good and so far it does not show any signs of falling off. The growth in areas which were completely clear felled is better than in areas where part of the overwood was retained as seed bearers.

Experimental 'group' and 'strip' fellings have been made in the Jubbulpore division to ascertain if these afford better shelter to the coppice against late frosts.

In Raipur, an experiment has been made to test the effect of fires on coppice shoots in the Low Forest of the Mixed Ranges. It is prescribed in the Working Plan that the coupes should be burnt after working, but in practice it is difficult to get the coupes cleared of fuel before the coppice shoots have reached 1′ or more in height with the result that the shoots are killed back by the fire and if the shoots are not actually injured anyhow the coppice loses its start ahead of the heavy grass which springs up after clear felling.

Experiments have provisionally shown that cutting back causes loss in height growth, and it makes no difference whether subsequent burning is carried out or not. It did also appear that if the plot was burnt, there was no loss in height growth. The reason was that in all experimental plots the area was so well cleared that the fire was light.

The Divisional Forest Officer considers that burning does not accelerate growth and that the mechanical effect of burning in removing the slash is of no importance here, as no slash remains except brushwood which rots in the first rains.

(iii) *Seeds.*

Seeding.—On the whole it was a poor seed year for teak. *Saj* (*Terminalia tomentosa*), *semal* (*Bombax malabaricum*), and *anjan*, seeded prolifically; all other species gave a moderate crop of seed. Bamboos (*Dendrocalamus strictus*) in the Kinwat range of the Yeotmal division seeded gregariously.

A general seeding of the shrub *Strobilanthes callosus* which forms a dense undergrowth to the exclusion of *Lantana aculeata* came to an end in 1934, this seeding having apparently commenced in 1933. The shrubs is believed to flower once in three years. Its seeds are eaten and apparently much relished by bison and domestic cattle.

(iv) *Nursery work.*

The important permanent nurseries were satisfactorily maintained, and small nurseries were started at several places during the year. Germination of teak was irregular but of *semal* quite good. Nursery sowings of *Acacia cyanophylla* seed obtained from Cyprus failed everywhere except in the West Berar division, where seed was sown on a raised bed of black cotton soil, and lightly covered with earth.

(v) *Artificial regeneration.*

Teak.—Experiments in the Melghat division to investigate the possibility of replacing lantana with tree growth were continued. Two distinct types of areas were selected which were treated in two different ways.

The first type contained overwood of very little value, having been mostly damaged or destroyed by the fierce fires of the past. It was decided to regenerate such areas in conjunction with field crops.

Except for a few trees reserved as seed bearers all other growth is felled, burnt and the ground is then cleared and ploughed up and sown in the rains with field crops. In the second and third year cultivation of field crop is continued. In the fourth year, seeds of forest species

are sown in lines 12′ apart, along with the field crop, and the forest seedlings are kept free from weeds. After the field crop is harvested the plot is left to its own resources.

The second type contained valuable overwood and it was decided to regenerate such areas without the aid of field crops. At the beginning of the first year the lantana is uprooted departmentally and stacked with the roots in the air all round the plot to serve as a fence to ward off browsing animals.

Strips running through the area at 12′ intervals are sown or planted up with teak or other suitable species to be kept properly weeded afterwards.

Preliminary results indicate that the eradication of lantana present no serious difficulties and that it can be easily got rid of, at least temporarily, by either method of treatment. With the sowing of field crop the eradication is naturally more thorough and permanent than without it. The stocking of the wooded area without field crop presents many difficulties. Direct sowings of teak and other species do not offer much prospects of success, but it is hoped that "stump-planting" or the 'dona' system will be more successful. It is anticipated that even under these methods weeding will be required for several years to ensure success.

Elsewhere, owing to the slump in cotton prices agri-silvicultural work has become unattractive, and attempts are now being made to raise teak plantations in Yeotmal, by the *rab* method, *i.e.*, by piling and burning all slash on the proposed site of seed-bed with a view to kill all the undesirable seed on it. About 4½ acres were successfully restocked as an experimental measure and it has now been decided to take up the work on a larger scale.

Propagation of Dendrocalamus strictus from rhizomes in the West Berar division.—Experiments to determine the circumstances under which the latent buds from the rhizomes throw out an independent and more vigorous shoot indicate that in grubbing out (roots of one year old shoots), care must be taken not to damage the rhizome the top of which should be cut except for one node. Results are very satisfactory if the rhizomes are exposed to the sun for some time before planting. Burning one year old planted out rhizomes gave excellent results. Almost all of them threw out new vigorous shoots.

Plantation work during the year.—Plantation work on a large scale is at present confined to the South Chanda and Bilaspur divisions with cuttings and 'dhonas' of teak, *semal*, *shisham*, etc. With a view to determine the best method of tending the plants, a set of four experimental plots have recently been laid out with 20 sub-plots, replicated in the Latin square chessboard manner, to compare the effects of weeding and cleaning of different intensity and periods.

Semal Plantations.—Of the five experimental plantations of *Bombax malabaricum* started in 1930-31 those of North Chanda (2) Bilaspur and Betul totally failed, while that of Nagpur-Wardha, where it has not been attacked by animals, is in a flourishing condition, some of the plants now being 15′ high and beginning to flower. The plantations which failed appear to have been on unsuitable soil, but as the Nagpur-Wardha plantation is hopeful a second area has been sown in the same neighbourhood, 12′×12′ with intervening rows of teak stumps. Damage by pig and deer is being guarded against by a barbed wire fence.

All India teak seed origin experimental plantation.—These plots were visited by the Silviculturist in December when thorough cleanings in both the "gneiss" and "schists" sets of plots were carried out.

In both sets of plots Nilambur and Mysore teak has attained much greater height than the teak of other origins, but this advantage is more than set off by the very poor form of the trees as almost all have forked at a height of from 5 to 10 feet from ground level. The teak of these two origins appears to be very susceptible to a shoot borer which has apparently been responsible for the malformation of the trees by killing the leading shoot, in place of which two or more leading shoots have resulted. These shoots have now been thinned, only the best being retained but even so the form of the trees is unsatisfactory and it is doubtful whether they will recover.

The percentage of well grown trees of Nilambur and Mysore origins is much lower than those of other origins, while the teak of local origins has the best form. It is thus doubtful whether teak of Southern India origin is really suitable for C. P. conditions. The Central Silviculturist in his note acknowledging the plot files says that the gneiss set of teak origin plots appears to be the most successful set reported upon from any centre, and the results are most interesting and valuable.

(vii) *Tending—Thinnings, cleanings, climber and weeds.*

Thinnings.—An experimental plot was laid out in the Nagpur-Wardha division, to study the best method of thinning multiple stems of young teak coppice.

Similar experiments will soon be laid out both for sal and teak coppice of various ages to determine the optimum age at which thinnings should commence, and also the ideal number of shoots to be retained in each clump.

Cleaning.—Coupes worked by contractors, need a general cleaning up for the crop left over. This work is done under the name of subsidiary cultural operations. These operations are seldom remunerative, but are none the less essential and therefore prescribed.

Climbers and weeds.—As a rule all climbers interfering with the growth of trees are cut in the year preceding the main exploitation or along with the main fellings. Of late considerable attention has also been paid to determine the most satisfactory methods of eradicating various obnoxious weeds, some of which are mentioned below :—

Mahul (*Bauhinia vahlii*).—This prolific, shade-enduring climber soon becomes a pest in areas containing sandy soils. Sudden exposure gives a great impetus to the climber.

Couitch (*Mucuna pruriens*).—A slender twining climber, which damages particularly younger plants, can be held in check by uprooting it before the fruit forms.

Raimuniya (*Lantana aculeata*).—This weed is capable of forming a dense and almost impenetrable mass in certain localities, but fortunately such areas are few. During the last rains lantana was eradicated along the road sites of the Chikalda plateau by means of men and elephants. But, these operations only temporarily hold the lantana in check, and the area gone over is a very small fraction of the total. In view of the fact that the pest is so widely spread in certain tracts, and also because it is not without its uses, inasmuch as (i) it definitely improves the soil, (ii) it is not very inimical to the regeneration of tree species unless very dense, and (iii) keeps down grass. It is doubtful whether complete extermination of lantana from the Melghat is practical or even desirable. No efforts are, however, being spared to study the most satisfactory method of eradicating the pest from newly infected areas, or preventing its invasion of areas so far free from it.

Tarota (*Cassia tora*).—This weed grows to the exclusion of fodder grasses, and spreads very fast in areas which are very heavily grazed, as it is not touched by the cattle. The most obvious method of preventing the spread of the pest is to close areas frequently to grazing, when the grass can easily suppress the weed.

Kunda (*Ischæmum pilosum*).—A very troublesome grass in agri-silvicultural plots. Unless it is thoroughly rooted out by deep cross ploughing before the seed of forest species is sown the cost of weeding is prohibitive.

(viii) *Mixtures.*

Fires, grazing and frost all tend to exterminate miscellaneoms species associated with teak with the consequence that the mixed forests are becoming more and more pure teak and soil deterioration through insolation is increasing. Every attempt is now being made to increase the proportion of soil sheltering miscellaneous species by leaving all well grown advance growth when teak is clear felled. In thinnings also, promising poles of miscellaneous species are retained in preference

to teak. Planting of *shisham* or *semal* along with teak in the recent plantation is a move in the right direction.

(x) *Silvicultural systems.*

Experience has shown that rigid clear fellings in the teak forests not only entail a great sacrifice of immature and at times unmarketable crop, but the slash left after exploitation greatly enhances fire hazard. The severe January frosts of 1931 and 1935 have clearly demonstrated the imperative necessity for more conservative fellings in low lying areas. The treatment now in process of adoption is a virtual introduction of an irregular shelterwood system.

(xi) *Miscellaneous including grazing, fire, frost, etc.*

Grazing.—This has been discussed at length in the last year's report. Now that definite areas have been set aside for the production of timber and fuel on the one hand, and for the supply of grass and grazing on the other, attempts are being made in the latter to improve the yield and quality of fodder.

So far nothing is known regarding the optimum treatment that will ensure this. The comprehensive experiments started in Yeotmal, and lately also in Saugor, to determine the yield of grass from pastures, in various localities, under different incidences and grazing closure cycles, are progressing very satisfactorily. It will take at least five years to arrive at any valuable results

Observations in the Yeotmal forests, which have now been under rotational closures with a limiting incidence for nearly 20 years, clearly show that periodical rests are very beneficial The ideal grazing closure cycle has yet to be determined.

In the West Berar division, three adjoining coupes closed to grazing in successive years afforded an excellent opportunity to study the changes in the composition of the grasses in heavily grazed areas on *murrum* soils.

The immediate effect of closure was a rank growth of spear grass (*Andropogon contortus*), which in the second year showed patches of *sheda* (*Ischæmum laxum*) and in the third year was almost completely replaced by it.

Tentatively a closure of 4 years alternating with grazing for 12 years has been prescribed in most of the "*Open Pastures*" of the Nagpur-Wardha division, and will be given a trial from the 1st July 1935.

Fire.—Opinions are divided on the comparative merits of wholesale early burning and the modified Khandesh system of burning inflammable growth from a little distance inside the forest towards all frequented

rides, roads and fire lines. Many forest officers consider the Khandesh method an unqualified success; no doubt the configuration of the ground lends itself to this treatment in one place more than another.

Frosts.—Late frosts are reported to have wrought havoc in several recently regenerated areas, especially in Hoshangabad and Melghat. Not only was regeneration killed or badly damaged but even large trees also suffered.

II.—Working Plans and Statistics.

(i) *Working Plans.*

North Mandla.—The revised draft is at present under modification.

Saugor.—Printed copies of the plan, which has been introduced from the 1st July 1934, will shortly be ready.

Betul and Amraoti.—These two plans were completed during the year and sanctioned by the Local Government.

Nagpur-Wardha.—Slight modifications were made by the Silviculturist in consultation with the Conservator. The plan has since received the sanction of Government and is to be introduced from the 1st of July 1935.

Akola.—Part II of the current plan was considered obsolete and was therefore entirely rewritten. The revised draft has received the sanction of the Chief Conservator.

North Chanda and Damoh.—Stockmapping has been completed and the plans are now being written.

South Chanda and Melghat.—Part of the field work in connexion with these two plans still remains to be done. Besides, amendments were made to some of the current Working Plans.

(ii) *Yield volume and form factor tables.*

Sample plots.—There were 94 sample plots on the Provincial list at the commencement of the year. Of these one was abolished and one converted into a tree increment plot. 20 new sample plots were laid out in the teak forests thus bringing the total for the province to 112, at the close of the year. The sample plots now cover a wide range of age and quality.

Tree Increment Plots.—There were five tree increment plots at the commencement of the year. One new plot was formed thus bringing the total to 6 at the close of the year.

Experimental plots.—There were 21 experimental plots at the beginning of the year. Of these five were abandoned during the year under report and 13 new plots were laid out, thus bringing the total to 29 at the close of the year.

III.—Miscellaneous.

Administration, tour, etc.

Mr. H. C. Watts held charge of the post of the Silviculturist from the beginning of the year to the 7th of March 1935, when he was relieved by Mr. K. P. Sagreiya, who held the post till the close of the year.

COORG.

I.—Experimental Silviculture.

Sandal regeneration experiments.

Sandal germination test.—Using 100 untreated seeds each of Coorg and Madras origins with and without pulp it was found that Coorg seed with pulp gave best germination (92 per cent.), Madras seed with pulp next (80 per cent), Madras seed without pulp slightly worse(75 per cent.), Coorg seed without pulp worst (29 per cent.). The results require confirmation.

Sandal seed pretreatment.—Seed received from Salem was soaked in water for 2 days, floating ones discarded and remainder dried in the sun for another 2 days and then stored for about 10 days. Towards the end of April they were treated in a shallow pit between two layers of straw and watered daily, the seeds being stived by hand frequently. After about a fortnight 50 per cent. of the seeds had burst, about half of which had radicle projecting. Such germinating seed dibbled at stakes in worked patches of soil gave 100 per cent. initial success.

Sandal propagation centres.—55 experimental propagation centres were opened, overhead shade being removed and the centres fenced. Treated seeds, stumps and transplants were tried, and considering the poor monsoon good stocking was achieved. Stumps gave about 75 per cent. success and seedling about 50 per cent. by the following March.

Planting stumps or seedling in small individual fences along road margins promise to be a successful method of increasing sandal stocking and costs 2 to 3 annas per fence.

Control of lantana by bamboos.—Long term experiments to see whether lantana can be suppressed by bamboos were started in these localities, bamboo seed (*Bambusa arundinacea*) being sown in patches under lantana bushes.

7. *Sandal Spike Disease Investigation.*—During the year control operations were carried out extensively to check the spread of spike disease. So far there was no fresh outbreak in the areas treated.

No fresh attacks have been noticed in Chowdlu village where an isolated case of spike was treated in August 1933. But in the case of Kargodc plantation a few more trees were found spiked and probably these must have been masking the disease at the time of treatment. Such trees were girdled and treated with Atlas solution and healthy sandal trees within 100' were lopped to see if they were masking the disease.

1. *Sandal 1934-35 areas.*—The method of regenerating sandal under clear felling, leaving 10 to 15 trees per acre as advance hosts was continued during the year with Fraserpet range.

There was a deviation from the original spacing of sandal and host plants. The areas were sown with sandal. Teak and *Cassia siamea* were introduced as host plants. *Dal* was also sown round each sandal plant. The reason why teak was introduced was because sandal has been found growing well on teak in natural forest.

Both teak and sandal are doing well at Attoor, whereas at Meenkolli sandal is good but teak is not very promising.

2. *Sandal 1933 area.*—In both the areas the existing stock is quite sufficient and the seedlings look healthy with an average height of 7 ft.

5. *Sandal propagation centres.*—Sandal was sown and stumps put out at 121 centres, which were fenced with rough basket fences $2\frac{1}{2}' \times 3'$.

In addition to the above 12 patches roughly 30' to 50' in diameter were opened, and treated seeds dibbled in them. Stumps and natural seedlings were also put into the area.

Stumps of more than 2 years old put out in August failed, whereas those of one to two years only put out in June were attended with partial success. Direct sowings and transplanting of natural seedlings were not very successful either.

6. *Nurseries.*—Three sandal nurseries were opened, two being directly sown with seeds, while in the third natural seedlings were transplanted. Results in the first one are quite all right, in the second very few seedlings exist as the seeds were severely damaged by rats, while owing to want of rain in time the 3rd nursery failed completely.

II.—Teak Regeneration.

4. The following experiments were conducted during the year at Dubare :—

(*a*) To find out the response of teak to fire at the end of the first year of formation in *soil aerated area.*

(*b*) To find out the response of teak to fire at the end of first year of formation in the *non-soil aerated* area.

Preliminary indications are that burning and aeration of soil are necessary in young teak areas.

(c) To find the response of teak to burning and cutting back in the second year of formation.

First year's results indicate that burning and cutting back results in better growth than without the same.

Mercara Sub-Range.

1 *Eucalyptus seed germination test*.—During the year the following 13 species of eucalyptus (as recommended by the Australian Forest Department) were tried at Mercara and their results are as follows:—

(1) *Eucalyptus umbellata*.—This species is doing well in the nursery as well as in the 1931 area, the tallest plant being 1'.

(2) *Eucalyptus bosistoana*.—This was quite good in the beginning in the nursery. After the commencement of the monsoon most of the plants died of leaf-rot.

(3) *Eucalyptus resinifera*, (4) *Eucalyptus paniculata*, (5) *Eucalyptus cloeziana* and (6) *Eucalyptus crebra*.—Seeds of these species were received late. They germinated in the seed bed, but by the time they were transplanted the regular monsoon had set in. As the plants were too small and tender, they all succumbed.

(7) *Eucalyptus microcorys*, (8) *Eucalyptus baileyana*, (9) *Eucalyptus andrewsi* and (10) *Eucalyptus citriodora*.—There was 25 per cent success in the nursery beds. Seedlings were planted in the 1931 area but they failed completely.

(11) *Eucalyptus pilularis*, (12) *Tristania conferta* and (13) *Eucalyptus saligna*.—These never germinated.

Miscellaneous.

Cedrela toona was very successful,—germination being 100 per cent. About one acre at the top ridge of the 1933 area was tried with *Cedrela toona*. When transplanting seedlings were too small and there was only 10 per cent. survival, the tallest plant being about 4" in height.

The 1932 burnt pit area was planted with 4,200 *Eucalyptus umbellata* and 3,800 *Cedrela toona* plants in pits at an espacement of 6'×6' by clearing the undergrowth. Only 20 per cent. of *Eucalyptus umbellata* and 12 per cent of *Cedrela toona* are now surviving.

South Coorg.

Makut Range.

1. *Object of experiment.*- (*a*) To observe the survivals and development of natural regeneration of valuable species when tended according to the prescriptions in the Working Scheme.

(*b*) The survival and development of artificially introduced valuable species such as *Hopea* transplants, etc.

A coupe of 53 acres felled in August and September 1934 was taken up for this purpose.

About two thousand *Hopea* natural plants were transplanted into the gaps caused by fellings which had been selected and wood growth removed. All natural seedlings, saplings and poles in the gaps and 10 feet around were enumerated and kept on record for future reference.

In October rubbish felling was done in one strip by removing all trees of useless species over 4' in guth. Here 6 gaps have been selected for observation. As a control over this, 6 gaps in the adjoining strip where no rubbish felling is done were selected for purpose of comparison.

The area is under periodical observation. The regeneration in gaps is quite good.

Tittimatti and Nagerholi Ranges.

ii. *Sandal.*

Sandal regeneration with a field crop has been discontinued during the year.

In the 1918 Bambookadu sandal area where a pollarding of all trees within a furlong radius of trees affected by spike was carried out last year, 39 more plants were attacked by the disease. They were uprooted after being killed by an application of Atlas solution. Besides these, two unpollarded trees were also attacked by spike.

iii. *Teak.*

Burning and cutting back in the second year of formation in teak plantations :--

This was carried out in 1933 regeneration areas, as prescribed in the Working Plan.

While the results cannot be considered conclusive yet, the operation does appear to have improved the growth of the teak plants.

The following experiments were carried out in Tittimatti and Nagerhole ranges :—

(1) *To determine the optimum season for stump planting teak.*—Stumps prepared from plants raised the previous year were planted at fortnightly intervals starting from 15th April 1934 to 15th July 1934 in case of Tittimatti and 2nd April 1934 to 2nd July 1934 in Nagerhole.

The two experiments indicate that planting between the 16th April and beginning of May is the best.

(2) *To compare stump planting of teak as against dibbling.*—An experiment has just been taken in hand and the idea is to compare dibbling and stumping teak in kumried and non-kumried areas. The age of plants at stakes originally dibbled and that of plants in the nursery kept for stumping will be the same.

(3) *To study the growth of sandal in plantations with teak as host.*—Sandal was sown on 21st June 1934 at 601 stakes in lines 8 feet apart and teak was dibbled at 710 stakes, 4 feet from sandal, changing species in each line so as to get the benefit of teak plants as hosts to sandal. *Dhall* and *Cassia siamea* were also introduced on 21st June 1934 as hosts. On 6th July 1934—121 sandal stumps were planted at every 4th stake of sandal, thus leaving 3 sandal stakes in the middle. On 30th March 1935 when enumerated there were 544 teak seedlings, 254 sandal seedlings and 121 sandal stumps surviving.

This is a long term experiment and the area is to be stocked fully and until sandal is 10 to 15 years old.

Sandal at stakes are growing well and some are as much as 26" high. The stocking is about 66 per cent. All the 121 sandal stumps planted have sprouted and growing well.

(4) *To study whether root competition from tree growth in the adjoining forests has anything to do with the growth of artificially grown teak.*—Preliminary measurements show a maximum height growth in the trench and the percentage of stocking is also more than that in control.

(5) *Teak seed origin experiment.*—To compare teak plants raised from Mysore seed with those raised from Nilambur seed, both having been dibbled in May 1934. Indications so far are in favour of the Nilambur seed, both as regards the percentage of survivals as well as of growth.

(6) *To study the effect of burning and cutting back teak areas in the second year of formation.*—Small plots were opened and the following treatments were carried out during the year :—

(1) Plot not burnt.
(2) Plot burnt but seedlings not cut back.
(3) Plot burnt and seedlings cut back.
(4) Plot not burnt but seedlings cut back.

Survival per cent is practically the same, but the maximum height growth is seen in the plot where burning and cutting back of teak seedlings is done.

(7) *To introduce Tephrosia candida as a cover crop in young plantations.—Tephrosia* has been sown to minimise the growth of weeds in teak plantations. Germination has been good and it is still under observation

MADRAS.

Experimental Silviculture.

(i) *General.*

Introductory.—In this brief report it is not possible to give full experimental data to support all statements made or opinions given nor does space permit mentioning all items of work undertaken. For fuller information the "Annual Report on Silvicultural Research in the Madras Presidency" for the year 1934-35 published separately should be consulted.

A large proportion of the work done has been small scale stage I (*a*) experiments in Experimental Gardens of which there are now 15.

The most important results during the year are the following :—

(1) The successful transmission of the spike disease of sandal by insects in the mass infection cages at Jowalagiri and Denkanikota.

(2) The success obtained by pre-monsoon stump planting of teak and other species in a year with an abnormally dry and prolonged hot weather.

(3) The demonstration of the retarding effect some *ponam* crops have on a teak plantation and how it can be minimized by early planting the teak.

(4) The successful storage of teak stumps and their transport to distant places.

(5) The confirmation of the fact that in our more important teak tests soil aeration by forking gives little or no advantage over ordinary weeding methods.

(ii) *Natural Regeneration.*

Experiments showed that a slight opening of the canopy over young natural regeneration of *Hopea parviflora* is beneficial.

Clearing under seed trees of *Hopea parviflora* was found to induce less natural regeneration than in the uncleared control areas.

Burning leaf litter under mother trees of *Artocarpus hirsuta* appears to increase the incidence of seedling regeneration.

Clearing undergrowth under *Swietenia macrophylla* mother trees does not appear to affect the incidence of seedling regeneration.

(iii) *Seeds.*

Seed pre-treatment.—Routine pre-treatment tests with cold, hot and boiling water were done with 19 species. Boiling water treatment improved the germinative capacity of *Acacia auriculiformis* and *Acacia cyanophylla* but was harmful for nearly all other species tried. The germinative capacity of *Pithecolobium dulce* and *Terminalia chebula* was definitely improved by treatment with hot water (as hot as the hand can bear) Soaking in cold water was beneficial in the cases of *Calophyllum elatum*, *Gluta travancorica*, *Pterocarpus santalinus* and *Xylia xylocarpa*.

Germination of *Cassia fistula* and *Cassia marginata* was greatly improved and hastened by soaking in concentrated sulphuric acid for 15 minutes and that of *Terminalia chebula* by soaking in cold water and then keeping moist in straw out of free air circulation.

Seasonal collection.—Tests of seed of *Tectona grandis*, *Terminalia crenulata* and *Terminalia chebula* collected at different times in the fruiting season showed no appreciable differences in germinative capacity.

Seed storage.—Tests were done with 28 species to determine the longevity of seeds stored in different ways. Results are given in the Annual Report.

Sorting seed by size.—Germination tests and planting out tests of different sizes of teak seed confirmed previous year's indications that sorting of this seed by size is not justified; the resulting differences in growth being negligible.

Tests with seeds from small immature, normal mature, and large overmature seed bearers with several species showed no appreciable differences in germinative capacity or in height growth of resulting seedlings.

Seed origin.—3 long term sets of plots in the All-India teak seed origin investigation have been successfully established and in each of the origins sample plots will be laid out when the first thinning becomes due.

(iv) *Nursery work.*

In hot dry fuel areas shady nursery beds gave higher germinative capacity with nearly all species tried but as regards subsequent development and survival individual species exhibited different requirements.

Nursery methods of raising Teak Stumps.—A comparison of (A) dense sowing with seed almost touching, (B) transplanting small seedlings into beds 4″×4″ espacement, (C) notching germinating seed from dumps 4″×4″ espacement, and (D) sowing soaked seed in lines 3″×1½″ espacement, showed that method (A) gave by far the greatest number of usable stumps per bed, though it is the most wasteful of seed. The beds, however, after removing the required stumps in the first year, will be again fully stocked with usable stumps at the end of the second year. The other three methods in no cases gave fully stocked beds, though the stumps produced were larger. Where the cost of seed collection is low and the cost of nursery space high, method (A) is evidently preferable.

Planting out experiments with the stumps raised by these 4 methods showed no indications that the stumps from one method were either better or worse than from any other method.

(v) *Artificial Regeneration.*

(a) *Mixed Deciduous Timber Forest.*

The stocking of felling gaps in mixed deciduous forest with teak is now extensively carried out and presents no difficulties in the initial stages. There is some cause for apprehension in certain areas however where climbers and lantana are particularly aggressive that the plants may be swamped by invasive growth in later years after tending has ceased.

An experiment comparing the effect of different intensities of burning in such gap regeneration showed that an increase of height growth of 50 per cent. was obtained with a light burn and 30 per cent. with a heavy burn when compared with no burn.

Comparison of direct sowing, entire transplanting and stump planting.—Previous year's results were confirmed and showed that for teak, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Anogeissus latifolia* stump planting is the best of the 3 methods while for *Xylia xylocarpa* direct sowing is to be preferred and for *Swietenia macrophylla* entire transplanting gives the best results.

Optimum season for stump planting.—Experiments were repeated and confirmed previous year's results. Last year had an abnormally prolonged and dry hot weather and early showers failed very badly in many places. In spite of this, planting in the middle of April gave good results for teak, *Dalbergia latifolia* and *Pterocarpus marsupium* and *Terminalia crenulata* showing that the risks of early stump planting due to a bad season are small (10—30 per cent.).

In these experiments it is very noticeable that the effect of the bad season on height growth is much more in the case of teak than with the other species mentioned.

Stump planting—effect of diameter of stumps.—Teak stumps of 0·4″-0·8″ diameter at the collum (—0·6″-0·9″ diameter at the thickest part approximately) gave the best results.

In the case of *Dalbergia latifolia* stumps 0·2″-0·4″ diameter at the collum and even larger appear to be best. For *Pterocarpus marsupium* results indicate that the larger stumps even up to 1·0″ diameter give the best results. For *Terminalia crenulata* stumps from 0·4″-0·8″ diameter appear best and for *Artocarpus hirsuta* those of 0·4″-0·6″ diameter.

Stump planting—effect of length of root—Teak.—Repetition of previous year's experiments confirm the indication that there is practically no difference in results from stumps of different root lengths within the range tried 4″-10″.

Stump planting—comparison of pits and crowbar holes.—Repetitions of experiments confirmed the slight advantage of height growth due to 1′ cube pits over crowbar holes but the difference is normally not likely to be worth the extra expense of digging pits.

Storage of stumps— Teak.—Experiments showed that stumps can be stored for 3 weeks before planting and still showed 70 per cent. survivals.

Transport of stumps—Teak.—Teak stumps from Nilambur were sent to 6 localities in different parts of the Presidency and in all 6 cases survived the journey. In 4 cases they are giving as good and better results than local stumps while in the other 2 cases they are not as good as the local stumps.

Casualty replacements in the 2nd year teak plantation.—Further experiments were intiated to watch the fate of casualties replaced with stumps in the second year of a teak plantation. Results so far indicate that few of these replacements survive and it is doubtful if they ever take their place in their main crop. The experiments will be watched for some years.

A repetition experiment showed that a *taungya* crop of *ragi* (*Eleusine coracana*) had a definite retarding effect on the height growth of a teak plantation of nearly 20 per cent. at the end of the first year. This retarding effect can be minimized by early planting the teak in the *taungya* as shown by another experiment in which, at the end of the first year, the teak in the *taungya* was 103 per cent. better in height growth and was still 85 per cent. better at the end of the second year.

(*b*) *Evergreen Rain Forests.*

All artificial regeneration work in evergreen rain forest comes under the category of underplanting and is therefore dealt with in part (ix) of this chapter.

(c) *Dry Fuel forests.*

During the year the new research centre at Emmanur in North Coimbatore has got into full swing and is beginning to give results.

Artificial regeneration of dry fuel forests by the "lab" method is being done on a larger scale each year in almost all divisions where this type of forest occurs and results are getting more encouraging as the technique improves.

In general, results indicate that (1) artificial regeneration by any method is best done at the beginning of the North East monsoon except possibly where watering is possible, (2) with most species entire transplanting is the best method of regeneration while with a few species direct sowing gives the best result, (3) stump planting is not a suitable method for this type of forest, (4) the following species may be regarded as "hopeful", *Acacia ferruginea*, *Acacia leucophloea*, *Albizzia amara*, *Azadirachta indica*, *Holoptelia integrifolia*, *Prosopis juliflora*, *Soymida febrifuga* by entire transplanting and *Cassia siamea* and *Tamarindus indica* by direct sowing.

Experiments show that burning before such regeneration work is beneficial but that soil working during weeding and tending operations is not beneficial as although it gives in general a slightly better height growth yet casualties appear to be much greater.

Stump planting of sandal has been done very successfully in the last few years. Sandal plants up to 4 years old have been stumped and given 85 per cent. to 95 per cent. success.

(vi) *Afforestation.*

Experiments were started during the year to examine the possibility of re-afforesting some of the important catchment areas of the Nilgiris. Many species were tried, all from seed, as no stock was available and great havoc was done by frosts which started a month earlier than usual. Seeds of shrubs were sown to raise nurses for frost tender trees and of these only broom and gorse successfully withstood the frost of the cold weather and the drought of the hot weather.

(vii) *Tending, thinning, cleaning.*

Weeding practice.—Definite confirmation was again obtained that forking as a method of weeding gives slightly but generally not signi-

ficantly better height growth than other methods such as mamooty scraping or weed cutting. It is evident therefore that soil aeration in itself does not confer any appreciable benefit over and above the effect of removing weeds. The expensive operation of forking in strips is therefore unnecessary and can be replaced by scraping which means a saving of approximately Rs. 5 per acre each time the weeding is done.

The experiments were all done in areas with a naturally light friable soil and a rainfall of 90"—120". The results may not be applicable to dry localities or stiff soils.

The effect of the competition of weeds was demonstrated by keeping 1 acre of plantation entirely free of weeds. The teak in this plot showed an increase in height growth of 163 per cent. in the first year and 165 per cent in the second year over the normally weeded control plot but had cost Rs. 31 8-0 at the end of the first year and Rs. 46-8-0 at the end of the second year for weeding alone.

Experiments in cutting back and burning a teak plantation in the second year were repeated. Results show that cutting back with burning gives slightly better results than cutting back without burning but neither of these treatments are as good as the control. The indications are that the plantations should not be treated in this way but if accidentally burned it is beneficial to cut back.

Thinning Research.—27 thinning plots were laid out at Nilambur in accordance with the scheme drawn up with the Central Silviculturist for the initiation of research into the best grades and cycles of thinning teak plantations. Similar plots are being laid out at Begur in the Wynaad division.

An experiment done at Vellore indicates that the cutting of thorny bushes in a dry fuel coupe at the time of felling definitely and greatly increases the pest.

(ix) *Underplanting.*

Burning in felling gaps in evergreen forest caused an average increase in height growth of 8 per cent. in the first year and 12 per cent. in the second year.

The general results of experiments of last year in underplanting in evergreen forest show that—

(1) for most species transplanting is the best method of regeneration,

(2) stump planting is not a suitable method for most evergreens,

(3) weeding is worth while as it gives a slight gain in height growth and in percentage of survivals,

(4) pitting for planting is also similarly worth while although the effects of the pitting do not show markedly until the second

year when the roots and their requirements have both increased,

(5) for most species July or early August appears to be the best month for transplanting rather earlier for areas of light rainfall (60"-80") and later for areas of heavy South West Monsoon rainfall (120"-250"),

(6) for most species the best size of transplant to use is from 8" to 1 foot high. Larger transplants occasionally do well but suffer very heavy casualties and are not definitely established for several years,

(7) there is very little difference in results between nursery and natural forest seedlings,

(8) basketing proved very successful in the case of *Dipterocarpus bourdilloni*,

(9) burning before natural regeneration under evergreen cover appears to produce no beneficial effects,

(10) application of repulsive agents does not decrease the browsing incidence.

(x) *Miscellaneous.*

Spike disease research.—Details of work carried out during the year cannot be given in such a brief report as this. The following are the outstanding results of the year's investigations :—

(1) Insects, especially the night fauna, form one of the carriers of spike infection (Spike has been transmitted by insects in 2 mass infection cages one of which is in a healthy area and one in a spiked area).

(2) The removal of sources of infection (spiked and disease masking trees) reduces infection considerably. The spread in spike controlled areas is *nil* whereas in the uncontrolled areas it is 5 times the original extent.

(3) In control operations lopping by itself does not render the trees more susceptible to infection.

(4) Resistance to a varying extent is built up in sandal associated with various hosts. No cases of infection with *Azadirachta indica*, *Strychnos nux vomica*, *Semecarpus anacardium*, and *Erythroxylon monogynum* have taken place and only 13 per cent. with *Cassia siamea*. It is to be noted that hosts imparting resistance generally contain a bitter or oily principle.

(5) Plants can be saved from infection by caging either with cloth or wire gauze of 10 or more meshes to the inch.

(6) Plants which resist artificial infection also resist natural infection. Only 3 per cent. which resisted artificial infection have got the disease from natural infection.

(7) Potted plants appear more resistant to infection than unpotted plants.

Periodicity of height growth.—Weekly measurements showed that the period of rest in most research centres started about November-December and ended towards the end of April but in 2 centres the plants grew right through the hot weather and did not rest at all.

Weeds.—Lantana —Suppression of *Lantana* by undersowing it with *Bambusa arundinacea* continues to look very promising.

Climbers.—Experiments in the eradication of *Zizyphus oenoplia, Acacia intsia, Pterolobium indicum* by poisoning with solutions of sodium arsenite of different strengths show that almost complete eradication can probably be attained by these means at a reasonable expenditure on chemicals

Euphorbia.—Experiments with 2 species of *Euphorbia* (*antiquorum* and *tirucalli*) show that they can both be killed by girdling but that felling is quicker and less costly than girdling for eradication of this pest.

II.—Working Plans and Statistics.

(i) *Working Plans.*

Five Working Plans were under compilation at the beginning of the year of which 3 were completed during the year. Three new plans were started during the year.

The cost of preparation, inclusive of establishment, varied from Rs. 0-3-4 to Rs. 0-3-9 per acre depending on the amount and intensity of stock mapping and enumerations necessary.

(ii) *Yield, Volume and Form Factor Tables.*

One hundred and two sample plots were maintained and the collection of data for local commercial volume tables was continued.

Seven tree increment plots in irregular forest were maintained.

III.—Miscellaneous.

(1) *Tours and Records.*—Owing to lack of staff the Provincial Silviculturist has had the greatest difficulty in doing the minimum of touring as he had been forced to remain at headquarters doing office work and routine computing.

The Silviculturist attended the All-India Silvicultural Conference at Dehra Dun in October-November 1934.

Opportunity was taken while touring in the Wynaad to visit the research experiments conducted in Coorg in accordance with the orders of Government to co-operate with the Chief Forest Officer, Coorg, in the conduct of such experiments.

Records.—The Specific and General Ledger files now number 418 and 143 respectively. 10 new experimental plots were opened during the year and the number of Experimental Garden experiments started or in progress during the year was 292.

Two hundred and thirtythree photographs were added to the collection of which 226 were taken by the Provincial Silviculturist.

Staff.—An extra Assistant Conservator of Forests was attached to the division as Assistant throughout the year. The subordinate staff now consists of 3 Rangers, 8 Foresters and 1 Forest Guard.

NORTH-WEST FRONTIER PROVINCE.

I.—Experimental Silviculture.

(i) *General.*

Silvicultural research continued, as in recent years, to be mainly devoted to finding out the best methods of restocking blue pine (*Pinus excelsa*) forests in which a seeding felling has been made under the uniform system of management.

(ii) *Natural regeneration.*

The sample plots laid down in the Pattan reserved forest to ascertain the most suitable intensity for a seeding felling in blue pine forests have still given no definite results. But further observations made in P. B. I. compartments confirm the view, expressed in last year's report, that the importance of overhead shade is a factor that has been exaggerated, that within reasonable limits the espacement of the seed-bearers plays less part in obtaining natural regeneration of blue pine than the condition of the soil at the time of felling, and that, in the case of this species, there must always be a fairly long waiting period, before the soil condition becomes suitable for a new crop to establish itself.

(iii) *Seeds.*

Local deodar seed is again reported to have given poor results as compared with seed obtained from Kashmir. The year 1934 was a fairly good seed year for blue pine and a fair one for deodar.

(iv) *Nursery work.*

Two new permanent nurseries were started in the Galis division to raise deodar and walnut. Owing to the damage done by voles, all nurseries here have to be fenced with wire mesh buried a foot in the ground with the buried end turned outwards, the whole area being thoroughly treated with a cynogas pump before sowings are made. This division reports that damage from cut-worms in the nurseries has been reduced by adding a mixture of quick lime and wood ash to the soil of the nursery beds.

A large experimental nursery has recently been started at Razmak, to test the suitability of various species for afforestation operations in the Waziristan hills.

(v) *Artificial regeneration.*

Cedrus deodara.—Patch sowing of deodar, preferably where debris has been burnt, continued to be the most widely used method for the artificial regeneration of this species. It is particularly successful under an overwood of blue pine, but everywhere birds do a considerable amount of damage in the early spring just as the seeds are germinating.

For planting, deodar seedlings 18 months old, transplanted either from the nursery or from the surplus in patch sowings, have given very good results, but with older transplants from patches, casualties are high. In Hazara, planting has hitherto been always done during the monsoon, and as an experiment, 3,000 transplants were put out this year during the winter, some immediately before snow fall and the rest immediately after the snow had melted. It is yet too early to say how these will compare with monsoon planting.

Pinus longifolia.—In the Peshawar division, one year old chir plants raised in tubes were successfully planted at Cherat and Malakand, both of which are only 3,500' high (in elevation) and outside the natural zone of chir. In both places, direct sowings made the previous year were a complete failure.

Pinus gerardiana.—Sowings of *chilgoza* were made both in the upper Kagan valley and at Peiwar Kotal in the Kurram Agency. The former failed, but the latter germinated well and it now remains to be seen whether the plants will survive the hot weather.

Juglans regia.—Winter planting of stumps from one year old nursery plants has now proved to be the most certain method of propagating walnut,—casualties being extremely few.

Fraxinus excelsior.—Stumps of ash, made from nursery plants, were put out on an experimental scale in the Kagan division and were completely successful.

Populus and Salix spp.—Willow and poplar cuttings continue to do well on land slips in the Galis. As an experiment, cuttings 3½ feet in length, with 2 feet buried in the ground, were tried at Thandiani, and gave far better results than the 1 foot cuttings used previously. Both *P. ciliata* and *alba* cuttings were successfully planted on land slips near Razmak, and they appear to be useful species for this locality.

Prosopis juliflora.—Experiments with mesquite sowings were continued in Lower Khanpur, and as a result of further experience it can now be said that trench sowings are the most suitable. Heavy casualties occurred during the post-monsoon period of drought and hares caused considerable damage but numerous seedlings have survived which although growth is slow are likely to be able to establish themselves.

Nannorhops ritchieana.—The dwarf palm is a species of the greatest economic importance in the Kohat district, its leaves being used for making mats and ropes, which commands a very large export trade. Nothing is known regarding the cultivation of this species, and experiments have, therefore, been commenced to ascertain a satisfactory method of propagation. Both seed and off-sets have been tried, with and without irrigation. Although a considerable number of off-sets send out shoots these invariably die off. The seed, which ripens in September, was sown in February and with irrigation germinated in April, but without irrigation did not germinate till August. Further experiments will be necessary before any definite conclusion can be drawn.

(vi) *Reclamation, etc.*

Since 1931, experiments have been carried out on two sample plots in water logged *kallar* lands, to test their suitability of such land for afforestation. These plots are near Pabbi, in the Peshawar district, on the right bank of the Kabul river, where there are thousands of acres of such land. The result of water logging, which is caused by the inadequate drainage of the rain water brought down from the Cherat hills, is a very high percentage of salts (*kallar*) in the top layers of the soil and a sub-soil water level which is never more than 5 feet.

Of the two plots one is irrigated with canal water and the other is unirrigated. During the four years these experiments have been in progress, the following have been tried :—stumps of sisso and mulberry, shoot cuttings of *farash* (*Tamarix articulata*), willow (*Salix babylonica* and *tetrasperma*), *chinar* (*Platanus orientalis*), *bakain* (*Melia azedarach*), and plants of various species of Eucalyptus.

In the unirrigated plot a small percentage of the stumps and cuttings sprouted, but they died almost immediately after; so did the eucalyptus, and in spite of repeated planting up this plot is still a complete blank. In the irrigated plot a large percentage of the stumps and

cuttings sprouted, but subsequent casualties were numerous, and only the following survive :—Sissoo 9 per cent., willow 20 per cent., *farash* 21 per cent, *Eucalyptus rostrata* 13 per cent., *E. rudis* 20 per cent. and *E. kirtoniana* 20 per cent. Most of these are very moribund, and only the few near the water channels, where the salts have apparently been washed out, are making any progress.

Results so far are most unpromising and the raising of fuel plantations on these water logged areas, even with irrigation, may never be an economic proposition.

(xi) *Miscellaneous, including fire and grazing.*

Further observations on the effects of closure to grazing show that in the case of both chir and blue pine, complete closure produces conditions unfavourable to the regeneration of these species. In the case of chir closure encourages the growth of imperata grass, while in the blue pine areas, the weed growth after closure is so heavy that the young seedlings are completely smothered by the mass of rotting vegetation that is pressed down on them by the winter snow.

II.—Working Plans and Statistics.

(i) *Working Plans.*

The working plans of the Lower Siran Chir forests and the Agror Reserved forests were revised and a combined plan prepared for the two areas. The same system of management is continued, *viz.*, the Uniform, revision being largely confined to a re-calculation of yield from complete instead of partial enumerations.

(ii) *Yield, volume and form factor tables.*

Statistical data for standard and commercial volumes from 70 deodar and blue pine trees were collected in the Lower Kagan forests and were sent to the Silvicultural Research division, Punjab.

PUNJAB.

I.—Experimental Silviculture.

(i) *General.*

Forest soils.—A party of the Irrigation Research Institute under Dr. Mackenzie Taylor, the Director, toured in Kulu during May-June with the Provincial Silviculturist, and took soil profiles in deodar, spruce, fir and *kail* forests of the Beas and Parbatti valleys in areas representa-

tive of the range of problems met with in these forests. The data relating to the distribution of main forest types have been worked up and are being published as an Indian Forest Record.

Prosopis juliflora.—The propagation of this species along the railway line as an additional work not included in the triennial programme was entrusted to the Research division. During the year 10,000 pot bound seedlings and 10 maunds of seed were supplied to various Railway Divisions, in which sowing and planting work was organised in co-operation with the Railway staff. On account of its value in the agricultural economy of the people and its marked capacity for resistance to general neglect, the species is eminently suitable for propagation as a means of natural afforestation in the various parts of the Punjab.

(ii) *Natural Regeneration.*

Picea morinda and Abies spectabilis.—No natural regeneration was obtained under *Strobilanthes* or hardwood types of vegetation irrespective of soil working.

In the Kulu division, natural regeneration was absent, except on ridges or under the trees or tall shrubs. It was experimentally found that opening the crop in strips running north-south gave better results than those running east-west, and the heavier the seeding fellings the better.

No natural regeneration came in the experimental plots of the Lower Bashahr division. In the Simla division also, the regeneration was absent in the typical pure forests of the fir zone, but abundant in the mixed forests.

Cedrus deodara. Kulu division.—In Rahni, with closure, progressive restocking of blanks with deodar has set in.

Upper Bashahr division.—With experimental closure of 4 acres of burnt area in the dry zone, the influx of regeneration has begun, the seedlings being conspicuous under the shelter of boulders.

Pinus longifolia. Hoshiarpur division.—With closure natural regeneration came in areas with 8-12 seed bearers per acre. Thick undergrowth of *Carissa* was found to be an adverse factor. Conditions in Una range were somewhat unfavourable.

Dendrocalamus strictus.—In the Hoshiarpur division, masses of seedlings were observed during the rains, but were destroyed by grazing, thus indicating the necessity for a longer period of closure.

Miscellaneous species.—In the Upper Bashahr division, abundant natural regeneration from suckers was obtained by trenching the ground round the mother trees of *Melia azedarach, Dalbergia sissoo* and *Cedrela toona.*

(iii) *Investigation on Seeds.*

(*a*) *Phenological data.*—Observations were recorded on 8 trees of *Acacia modesta* and *Olea cuspidata*, growing on different aspects and elevations in Kalachitta hills. The indications are that the annual phenomena of flowering, seeding, etc., are not correlated with aspect, elevation and underlying rock.

(*b*) *Seed year.*—The seed harvest for deodar was good, for *kail* moderate, and for *chil* poor (except in the Hoshiarpur division). The flowering of individual clumps of *Dendrocalamus strictus* was below the average.

(*c*) *Seed weighments.*—Routine weighments were taken for seeds of the species which were experimentally raised in the nurseries at Manali. Samples of *kail* and deodar seed from different localities showed appreciable difference in weight. Deodar seed from Hazara was found to be heavier than the average sample collected in the Kulu valley and inner and outer seraj ranges. The *Olea* seed from Khanpur was found to be pronouncedly heavier than the Kulu seed. It was observed that there was a general tendency for seed weight of a given species to fall off towards the upper altitudinal limit of its habitat. With regard to seed from trees of different diameter classes, no systematic trend was observed correlating weight with these classes. Weighments were taken for 17 species, and a minimum of 4 weighments were taken in each case.

(*d*) *Seed storage.*—Seed storage tests, mostly carried out at Manali, comprised all the coniferous species raised in the nursery, including the exotics. For all these species, serious deterioration in the vitality of the seed was indicated with storage for 6-12 months. Only in the case of *Pinus excelsa, Picea morinda* and *Larix europæa* appreciable viability was retained after about a year.

(*e*) *Germination tests (without pretreatment).*—These were made with the untreated seed of *Cedrus deodara, Pinus excelsa, Pinus gerardiana, Acer pictum* and *Alnus nitida* at Manali, and *Acacia modesta, Albizzia lebbek, Butea frondosa, Cordia obliqua, Dendrocalamus strictus, Eucalyptus citriodora, Melia indica* and *Pithecolobium dulce.* The variation in the germination per cent. of seed of *Cedrus deodara, Pinus excelsa* and *Picea morinda* collected from different diameter classes did not show any systematic trend with reference to these classes. *Pinus excelsa* seed from high level crops was found superior to that from low level areas in germinative capacity. Brown pods of *Acacia modesta* gave better results than the green ones. *Eucalyptus citriodora* gave significantly higher germination under shade than in the open.

In the Upper Bashahr division, germination tests with deodar seed from different localities and age classes indicated that the germina-

tive capacity of seed collected from middle-aged trees was better than that collected from mature and over-mature trees.

(*f*) *Germination tests with pretreatments.*— At Manali seed-pretreatment, consisting of soaking in cold water for 12, 24, 36, 48, 72 and 96 hours and in hot water at temperature of 120°, 150°, 180° and 192° was tried for *Pinus excelsa* and *Picea morinda*. Soaking in cold water for different periods and in hot water up to 150° did not make any difference in the germinative capacity or the germination period, but soaking in hot water at higher temperature killed the seed. At Chichawatni, soaked seed of different forms of *Prosopis juliflora* gave better results than the untreated seed.

In the Multan division, it was found that soaking seed in cold water for 2-4 days for *Melia azedarach*, 3-4 days for *Rhus lancea*, and 4-6 days for *Cordia obliqua* stimulated germination. In the case of *Cordia*, it was essential to remove the hard covering before sowing.

(iv) *Investigation on seedlings.*

(*a*) *Seasonal height growth.*—Periodic height measurements were recorded for all the important species raised in the nurseries at Manali and Chichawatni.

The following observations were recorded with regard to peak growth in relation to temperature data :—

Plants for which the peak growth occurs before the incidence of mean maximum monthly temperature.—*Olea cuspidata* (seedlings), *Tamarix* (coppice and seedlings), *Dalbergia sissoo* (seedlings), *Melia azedarach* (stumps).

Plants for which peak growth coincides with the month of incidence of the mean maximum monthly temperature.—*Acacia catechu* (seedlings), *Melia azedarach* (plants), *Acacia modesta* (stumps and seedlings), *Morus* (stumps and seedlings), *Dalbergia sissoo* (stumps) and *Tamarix articulata* (seedlings).

Plants for which the peak growth follows the incidence of the mean maximum monthly temperature with a lag of 1-2 months.— *Melia azedarach* (seedlings), *Tecomella undulata* (seedlings), *Tamarix* (branch cuttings and stumps), *Dalbergia sissoo* (coppice and stumps).

The following species exhibit a two-peaked curve of growth, the second peak occurring in September during which month temperature rises again after the rains.

Tecomella undulata (seedlings), *Tamarix articulata* (coppice, cuttings, stumps and seedlings), and *Dalbergia sissoo* (stumps).

(*b*) *Type and incidence of frost injury.*—At Chichawatni observations were recorded regarding the type and incidence of frost injury. Different species were found to vary from each other in the degree of susceptibility to frost injury. A rough classification of the species according to the intensity of the injury sustained is as under :—

Species which completely escaped frost effect.—Eucalyptus tereticornis, Melia azedarach, Olea cuspidata, Tamarix articulata, Prosopis juliflora (Argentine form).

Species for which the injury was confined to the die-back of the growing tips only.—Acacia modesta, Dalbergia sissoo, Dendrocalamus strictus, Eucalyptus melanophloia, Maclura aurantiaca, Morus alba, Tecomella undulata, Prosopis glandulosa, Prosopis juliflora (arid and Mexican forms).

Species for which the die-back of the shoots extended down to ground level or at least one year's growth.—Acacia catechu, Albizzia lebbek, Bombax malabaricum, Capparis aphylla, Cordia obliqua, Dodonæa viscosa, Eucalyptus citriodora, Melia indica, Prosopis juliflora (Peruvian and Australian forms).

The above classification is only an approximate one and strictly applicable to climatic conditions prevailing in Chichawatni. Even here within the same species the behaviour of individuals was found to vary between wide limits. Thus four plants of *Acacia catechu* practically completely escaped injury in marked contrast with the remaining individuals of the species which suffered badly. This variation in the frost resistance of individuals was more marked with *Prosopis juliflora* than with any other species, and is probably ascribable to the ease with which the different forms appear to hybridise among themselves, particularly the Mexican and the Australian forms. This indicates the importance of isolating and propagating the hardy individuals and races.

(v) *Artificial Regeneration.*

(*a*) *Indigenous conifers.*—Artificial regeneration works aiming at developing the technique of sowing and planting conifers under different forest conditions were concentrated in Kulu in Manalgahr, Rahni, Bajraundi, Kangni, Hathipur and Nakas forests. 2-3 year old seedlings of *Pinus excelsa* and *Abies spectabilis* transplanted in the rains gave good results. *Picea morinda* tube planting proved most successful.

In the Hoshiarpur division, 270 tubes containing 1-year old *chil* seedlings put out in July gave about 52 per cent. success.

(*b*) *Exotics.*—The following exotic conifers were tried under forest conditions to test their silvicultural value :—

Larix europea, Larix kæmpferi, Larix griffithii, Thuja plicata, Pseudotsuga taxifolia, Chamæcyparis obtusa. Tarodium distichum, Cryptomeria japonica, Picea excelsa, Picea sitchensis. Pinus patula, Pinus tæda. Pinus pinaster, Pinus sylvestris and *Pinus laricio.*

Of these exotics, larch has proved so far the most promising species on account of its adaptability under a wide range of conditions under which it has succeeded. *Pinus laricio* has stood the snowfall and the severe winter of Manali. Seedlings distributed for trial in other divisions did not stand transport well, and gave poor survival percentage. Only *Pinus tæda* seedlings sent to Mandi State gave 80 per cent. success.

(c) *Other species.*—The species tried were those suitable for large scale cultivation under conditions inhibiting the growth of the local species.

The following notes give the results obtained so far :—

Acacia modesta.—Patch sowings along trenches gave 85 per cent. success in the Research division, but in the Rawalpindi West division, heavy casualties occurred on account of drought.

Cedrela toona.— 1,313 seedlings transplanted with balls of earth gave 100 per cent. success in the Hoshiarpur division. The introduction of *toon* in the *chil* forests of this division is considered desirable on account of its timber and protection value.

Eucalyptus spp.—Heavy casualties from white ants occurred among the plants of *Eucalyptus citriodora. Eucalyptus melanophloia, Eucalyptus tereticornis* and *Eucalyptus rostrata* inspite of repeated applications of nicotine solution (*hukka* water) in the Research and Montgomery divisions. *Eucalyptus citriodora* proved susceptible to frost.

Maclura aurantiaca.—Only transplanting was successful in the Research and Montgomery divisions, but both sowings as well as planting gave very good results in the Multan division. The species seems suitable for restocking failures of *shisham* on poor soils; transplants have succeeded on the hard clay soils of Pirawalla.

Prosopis juliflora.—Different forms were tried in the Research and other divisions. In Miranpur and Chichawatni, Argentine and Mexican forms proved frost hardy. Heavy casualties occurred among the transplants in Bata plantation on account of late transplanting. In the Depot West division, only frost hardy forms were found suitable for introduction in the dry *rakhs* and highland *belas*. In the Phillaur Reserve, transplants of the Peruvian form gave 60 per cent. success.

Tamarix articulata.—In the Research and Multan divisions, sowings on raised beds gave the best results, while in the Montgomery division, sowing on mounds with circular trenches round them was considered the best method of propagating the species. But success varied with the soil, as the species is very exacting as regards its soil requirements.

Underplanting of mulberry.—In the Multan division, the suitability of underplanting mulberry immediately after the first thinnings was experimentally established.

(vi) *Nursery Work.*

(*a*) Stock of various species was raised :—

(*b*) *Experiments.*—The following experiments were carried out :—

Manali.—1. To determine the best size and season for planting branch and root-shoot cuttings of broad-leaved species occurring in the hills.

Winter planting of stumps and branch cuttings of *Populus*, and spring planting of stumps of *Aesculus* and *Juglans* were most successful.

2. To determine the effect of different types and thickness of humus on the growth of *Picea morinda.*

Best results were obtained with fully decomposed humus.

3. Comparison of entire and pruned plants of blue pine and deodar for transplanting.

Pruned seedlings of blue pine gave better results than the entire plants.

Chichawatni.—4. Comparison of entire and pruned plants of *Dendrocalamus strictus.*

Entire plants and early planting gave better results than pruned clumps and late planting.

5. To determine the effect of different intensities of shades on the development of bamboo seedlings.

Partial shade significantly improved height growth of plants.

(vii) *Reclamation and afforestation.*

Counter-erosion work.—In Nurpur forest, an area of about 20 acres was fenced as a measure of counter-erosion, and the following species were tried :—

Euphorbia royleana, Opuntia monocantha, dillenii and *stricta, Jatropha curcas, Agave americana, Thevetia neriifolia* and *Aloe vera.*

Agaves and *Aloes* have succeeded.

(viii) *Thinnings and cleanings.*

In all the divisions, thinning programmes have been worked to date.

II.—Statistical Research.

Sample Plots.—Full remeasurements were done for 4 *Eucalyptus* and 4 *shisham* plots, final measurements for 4 clear-felled *shisham* plots, and interim measurements for 8 *Populus euphratica* plots.

Other statistics.—The total number of trees measured for standard and commercial volumes data were 7,300 and 2,356 respectively up to the close of the year.

Conversion factors.—These were worked out for *Olea cuspidata, Acacia modesta, Acacia arabica, Eucalyptus rostrata, Prosopis spicigera* and *Melia azedarach.*

III.—Miscellaneous.

Rainfall statistics.—Rainfall statistics were maintained and a consolidated annual statement was compiled from the data.

Photographic collection.—Routine filing and indexing of photographic collection were carried out. 67 prints were added during the year, thus bringing the total of the collection to 1,425 prints.

Records.—9 specific and 13 general ledger files were opened during the year, the total number of files now being 440 of which 129 are specific and 311 general files.

Library.—The Punjab Forest Library was maintained by the Research division. 80 new books were added during the year in addition to serial bulletins and other periodic literature.

Working Plans.—Three working plans and one working scheme were completed while three working plans were under preparation during the year.

Staff.—Mr. I. D. Mahendru, P.F.S., was in charge of the Silvicultural Research division during the broken periods, April to June 1934 and again January to March 1935, Mr. Partap Singh, I.F.S., being in charge during the intervening six months.

UNITED PROVINCES.

I.—Experimental Silviculture.

(i) *General.*

The most important problem being attacked at the moment is sal natural regeneration. On the statistical side, in addition to normal work sal linear increment plots are, perhaps, the most important.

The number of sanctioned experiments under the Silviculturist decreased from 68 to 66.

(ii) *Natural regeneration.*

(*a*) *From seed.*

Shorea robusta (*sal*).—The Experiments on the natural regeneration of *sal* are progressing favourably. A short leaflet will be published for the information of local officers, telling how the experiments are progressing, but no theory of how to obtain natural regeneration of *sal* will be given in the proposed leaflet yet.

(*b*) *From coppice.*

Shorea robusta (*sal*).—Experimentally there is nothing to report. Coppice can be obtained with the greatest of ease, and although deer can be controlled, severe frost still presents the real difficulty. Scattered frost-protecting overwood is all right against certain frost but it does not protect against really severe ones.

Acacia arabica (*babul*).—Repeated frost damage is ruining *babul* coppice in Etawah, mortality being now up to 48 per cent of the trees coppiced in January 1931. After five years' growth the average diameter of surviving coppice shoots is almost exactly one inch at a height of 2 ft. from the ground. The original trees coppiced were two to four inches in diameter at breast height.

Hill oaks.

Quercus incana (*banj*).—It is easy to coppice and shows now 62 per cent survivals. Smaller diameters are the best coppicers, the three inches diameter class showing no mortality, mortality gradually increasing up to 10 inches diameter class, above which there are no coppice survivals. The average height for all plots in six years is six and a half feet.

The above refers to the Bhawali plot at an altitude of 5,600 ft. In the higher plot at Kilberry (altitude 6,500 ft.), the survivals are only 40 per cent. Their growth is naturally slower, the average height in six years being only four feet.

Quercus dilatata (*moru*).—Apparently not a good coppicer, survivors being only 14 per cent with an average height of 1′ 7″. There is however heavy browsing by deer, which may be the chief cause of failure of the coppice.

Quercus lanuginosa (*rianj*).—Apparently a good coppicer, with 55 per cent survivors and an average height of about 4 feet in six years (same as *banj* oak) in the same locality.

(iii) *Seeds.*

The distributing agency for seeds at Clutterbuckganj continues. All seeds are now supplied free to other divisions, but outsiders are charged cost price only. Germination tests continued. Babul seed after five years of storage showed good germination. A small quantity of 1933 *Cupressus torulosa* seed was collected in June 1934 from old cones still on the trees. Good germination of this old seed was reported from Kenya.

(v) *Artificial regeneration.*

Shorea robusta (*sal*).—*Taungya* is becoming increasingly important though many consider that there is likely to be a swing back towards natural regeneration in future. Artificial work, however, has helped in tiding over an awkward period and will always be important. In the Haldwani experiment of sal mixed with *boga*, the *boga* again protected the young *sal* from the severe frost of January 1935.

Tectona grandis (teak).—The All India Teak Seed Origin experiment in Gorakhpur is developing well, all the main plots being now completely stocked. The parallel experiment in Haldwani division (Lakhmanmandi) was badly frost bitten in January 1935 and about half the plants had to be cut back.

Ischæmum angustifolium (*baib* grass).—Reports on *baib* again vary. Plots on *bhur* (sandy land) are now giving 9 maunds an acre from those planted in 1929-30 and nearly 7 maunds from those planted in 1931. In Pilibhit, the grass-yield seems to be from 5 to 16 maunds per acre, though the *baib* is damaged by frost and browsing. In Gorakhpur, the yield is about 12 maunds per acre, but the grass appears to be disappearing and plantations are not being extended. In the Afforestation division, the yield is about 6 maunds and the Divisional Forest Officer reports that results do not justify cultivation of *baib* in that locality. To sum up, all one can say is, that *baib* cultivation is not worth while on unsuitable soils and that it is too early to say very much more about suitable areas.

Santalum album (sandal).—Seeds from Coorg, Mysore and Madras were sown round lantana in the Tarai and Bhabar in 1933 and Coorg and Madras seeds again sown in 1934. Both times the Coorg seed has done better than the Madras seed, although Coorg reports that Madras seed is better than the local seed. The plants from the 1933 seed are now two to four feet high with woody stems. Sandal seed does not seem to germinate well enough to give good seedlings in the nursery. The Divisional Forest Officer, Jhansi, reports slightly differently. He obtained good germination from seed sown among bushes but reports that it also germinated quite well in the nursery.

Morus alba (mulberry).—A leaflet has been published on this for the information of local officers. Experiments made with cuttings of different thicknesses, from half an inch up to three inches, showed that thickness had very little influence either on survival percentage or on average height,—except, that on both clayey and sandy soils thicker cuttings gave slightly better height growth.

Eugenia jambolana (*jaman*).—An experiment between entire transplants and cuttings, put out in July 1934, seems to show a distinct advantage in favour of cuttings, survivors at present being 94 per cent as compared to 65 per cent for transplants.

(vi) *Reclamation and afforestation.*

Usar (*Saline Soil*).—A leaflet has been published on the Mukhdumpur experiment between Lucknow and Cawnpore. The tentative conclusions arrived at are as follows :—

(1) Annual protection during the rains, followed by grass-cutting and then opening to unrestricted grazing in the cold and hot weather causes a slow increase in amount of grass as determined by the yield when cut.

During 1934 the increase in the amount of grass continued, being 9¾ maunds per acre, compared with 5 mds. in 1933.

(2) Complete protection for 1½ years (two rains) causes a further improvement in the amount of grass, but this improvement is checked and actually decreased by subsequent treatment as under (1).

During 1934 with continued treatment as under (1), the response was the same as (1), the yield increasing from 5¼ to 8¼ mds. per acre, which is actually less than that obtained under (1). That is to say, protection for 1½ years, followed by treatment annually as (1) produces no ultimate improvement greater than that obtained under treatment (1).

(3) Continued protection, with no grazing at all, causes a much better progressive improvement in the grass. It is immaterial whether the grass is cut after it has seeded or not.

The progressive improvement continued during 1934, the yield in plots 1·2 (cut annually since 1931) and 2·2 (protected for 1½ years and then cut annually since 1932) being 12 and 10¼ maunds respectively per acre, compared with 9¾ and 9 maunds in 1933. The yield in plots 3·1 and 3·2, cut for the first time in November, 1934, after continued protection since July, 1931 was 11 maunds per acre, showing again that with continued protection it is immaterial whether the grass is cut after it has seeded or not.

An interesting point which has emerged from the study of the ecology of *usar* areas in this experiment is that of the two main *usar* grasses, *Sporobolus arabicus* and *Chloris montana*, the former is definitely decreasing while the latter is on the increase.

Bhur (riverain sand).—The Ujhani experiment has been further damaged by the fungus *Ganoderma lucidum*. Further observations are being made.

No further work is being done on the *bhur* area at Kanjhera near Lucknow. The severe frost and fierce hot weather show that it is practically impossible to grow any trees on the area without regular gardening. *But there is not much difficulty in afforesting the bhur* areas along the canals in the Afforestation division. *Khair* and *sissoo* can both be grown, and, with care, various other species as well.

The Faridpur experiment also showed how well *khair* can do on *bhur*. It also appears that mulberry does quite well, which is extremely frost hardy.

Afforestation of chandars by taungya.—The experiment in the Pilibhit division has not yet advanced far enough to give a report.

(xi) *Miscellaneous.*

As suggested by the Central Silviculturist (Indian Forest Record Vol. XIX, Part II) that controlled burning should be carried on for a much longer period than hitherto in the moist high level alluvium sal type, one of the South Kheri experiments which had been abandoned after having been burnt continuously from 1925 to 1934 with the exception of 1933 has been reopened.

Resin tapping.—The large resin tapping experiment near Garhkhet is being continued. The average yield for the whole experiment was 7 mds. 12 srs. per hundred channels, but the individual plots vary considerably. This year five of the experiments showed the greatest yield *with deep tapping and one with shallow tapping. Taking the three* straight grained experiments together, deep tapping gave the greatest yield while the shallow and medium were about the same. This is in contrast to the record of last year, when the shallow tapping gave the greatest average. Taking the three twisted plots together—the order is the same as last year—shallow tapping gave the most yield, deep next and medium least. But this year deep tapping is a very close second, and the only reason the shallow comes first is because of exceptional yield from one of the shallow tapped plots. While again emphasising that results based on only two years' work are not conclusive, it may be pointed out that although the maximum yield of an individual plot was obtained from a shallow tapped plot, the results certainly now appear to favour deep tapping so far as yield is concerned.

II.—Working Plans and Statistics.

(i) *Working plans.*

The only working plan completed during the year was for Ramnagar.

(ii) *Yield Tables.*

Permanent sample plots.—Sixty-five permanent sample plots and three statistical experiments maintained on the sample plot basis, were measured during the year.

Linear sample plots.—This statistical research in irregular *sal* forests was commenced only last year In addition to the 13 plots reported on last year, twelve more plots were laid out in the 'Moist Siwalik Hill Sal' and the '*Dun* and *Bhabar Sal*' forests of Ramnagar and Haldwani divisions The total length laid out was nearly eighteen miles, thus bringing up the grand total to thirty-one miles at the close of the year.

These lines run straight through representative compartments selected by working plan officers, and are mostly from a mile to a mile-and-a half long and a chain wide.

Increment of trees retained in regeneration fellings.—Extensive new sal regeneration experiments in the Haldwani and Ramnagar divisions with their numerous plots and fellings of various degrees provided an excellent opportunity for the collection of this data. All the sal standards in these experiments are therefore being numbered and carefully measured for increment.

Increment of tapped and untapped chir trees.—Analysis of the data confirms the preliminary indications that tapping causes an increase in diameter increment at $4\frac{1}{2}'$ but a decrease at 15' *i.e.*, above the limit of tapping. A bulletin will shortly be published on this.

III.—Miscellaneous.

There is nothing of extra provincial interest to report under this head. The Silvicultural Branch has started a series of "leaflets" for the dissemination of information of local importance within the province, in order to keep the territorial staff in touch with the Research Branch with a view to make use of even tentative results, if and where applicable.

They are primarily for domestic use only, and will not be given the same publicity as the Forest Research Bulletins.

A propaganda leaflet was issued in English, Urdu and Hindi on "taungya" cultivation explaining briefly its advantages.

CHAPTER III.—FOREST BOTANY.

ASSAM.

I.—Oecology.

During the year under review it was found possible to identify some of the grasses, woody plants and herbs of importance collected last year from the *sal* forests of Goalpara.

An endeavour is being made to collect complete data for the detailed study of all the vegetation of the important *sal* experimental plots of that division.

A botanical investigation of all the plants that occur in the forest tract between Pynursla and Dawki in the Khasia and Jaintia Hills has been started. The area has been recently opened up with the construction of Sylhet-Shillong road.

II.—Systematic.

Investigations regarding two species of *Lauraceæ* and one species of *Myrtaceæ* have now been completed and the results are being described and published shortly as new to science.

The Forest Herbarium has generally been maintained in good condition. Over 2,000 sheets have been mounted during the year. The replenishing of the herbarium with new collections has been continued and about 300 specimens have been added during this year bringing the total to about 20,800. A fair amount of identification work was carried out locally for the herbarium and Divisional Forest Officers. About 1,000 specimens of old collections which had been previously named (were named before) were examined and were properly housed in the herbarium after necessary treatment.

126 duplicate specimens were supplied to the Dehra Dun herbarium.

The post of Botanical Forest Officer was held up to 7th August 1934 by Mr. A. Das, who has since been succeeded by Mr. C. Purkayastha.

BIHAR AND ORISSA.

Pathology.

A series of fungus fructifications were collected and sent to Dehra Dun for identification. They were reported as causing the death of *sal* trees in Compt. 12 Samta (Saranda division) and in Compt. 14 Kodalibad and were identified as *Fomes melanoporus*, *Fomes fastuosus* and *Fomes tricolor*. These are regarded as fungi dangerous to *Shorea robusta*.

BURMA.

The post of Forest Botanist remained unfilled, Mr. R. W. V. Palmer, I.F.S., held charge of the office in addition to his own duties as Silviculturist throughout the year. Maung Kan, Curator of the Herbarium, reports as follows :—

Herbarium.—The Herbarium was generally maintained in excellent condition. Altogether 917 sheets were mounted during the year, bringing the total to 38,733 sheets at the close of the year. A considerable quantity of partially named specimens was sent to Dehra Dun and Calcutta for naming.

Presentations and Additions.—We are especially indebted to Mr. C. E. Parkinson, Forest Botanist, Forest Research Institute, Dehra Dun, for a collection of 250 botanical specimens for the Herbarium, and to Brigadier C. C. Foss, V.C., D.S.O., Maymyo, for his valuable gift of nearly 250 specimens collected by him in the vicinity of Maymyo. Contributions were also received from Mr. A. Long, Extra Assistant Conservator of Forests, Taunggyi.

Distribution.—Duplicate specimens were distributed to the following institutions as follows :—

1. Royal Botanic Garden, Edinburgh	30
2. Forest Botanist, Forest Research Institute, Dehra Dun . .	50
3. Forest Botanist, Forest Research Institute, Kepong, Selangor, Federated Malay States	31

CENTRAL PROVINCES.

I.—Ecology.

Nil.

II.—Systematic Botany.

Identification of plants in the Betul division was continued. Only one new species of an epiphytic orchid was found. This was *Vanda parviflora.*

The flora section of "The Guide to Pachmarhi" was revised by Mr. H. S. George, Deputy Conservator of Forests.

III.—Pathology.

Over 75 per cent of the older *babul* plantations of the Bhongaon reserve of the West Berar division are attacked by *Fomes pappianus.* In the Loni plantations the damage is much less. The virulent attack in the former is probably due to the practice of not ploughing up the land at the time of sowing; consequently the roots of the attacked trees

were left in the ground and on these the fungus continued to live till the advent of new plants.

PUNJAB.

Forest Botany.

(*a*) *Growth forms and physiological races of Punjab Plants Research Division.*—Systematic study of growth forms of *Prosopis juliflora*, and physiological races of deodar and blue pine was initiated.

(*b*) *Ecological succession.—Lower Bashahr Division.*—In the experimental plots at Shermali and Seri laid out in burnt areas observations on ecological succession were continued.

CHAPTER IV.—FOREST ENTOMOLOGY.

BIHAR AND ORISSA.

Forest Entomology.

A few living beetles of *Stenocera* were collected from Pelwal lac orchard found living on stumps of *Acacia catechu* damaging some Larvae of *Stromatium barbatum* were found in branches of stag-headed *sal* trees in Sambalpur East but were not the cause of the stag-headedness. Further research into the cause is being undertaken.

Angul. The teak defoliators (*Hyblaea puera* and *Hapalia machaeralis*) continued to do damage in the teak plantation.

BURMA.

Xyleutes ceramica Wlk., the Beehole Borer.

Life-history.—In the Thogale cage six individuals have been reared from egg to adult in a twelve months life-cycle. In the Maymyo cage three individuals were reared with two years life-cycle. Larvae taken from teak were introduced into trees of *Callicarpa arborea* in which they survived several months.

Mating of captive females with "called" wild males was obtained when the females were two to four days old. The females oviposited and died within six days.

Emergence was recorded in Thaungyin division in mid-February to end of March; in South Toungoo division in mid-April; in Shwebo division in the first week of May.

Life-history observation plots.—(*a*) 1933 attack. Out of an initial attack of 400 individuals in the early rains of 1933 all except 13 had failed by January 1935 and four moths emerged in March-April 1935. Five moths emerged in 1934. Woodpeckers were responsible for the destruction of at least 165 of the population. (*b*) 1934 attack. Out of an initial attack of 25 holes in June and 33 additions in July 1934 only 20 working larvae were recorded in March 1935. Two moths emerged after a life-cycle of one year.

Analysis of past attacks.—Four natural trees were hand analysed in South Toungoo division and others in Pyinmana division. Mill analysis of plantation and natural trees was continued by the Forest Economist and the Entomologist. Results will be published during the following year.

Natural enemies.—A parasite of the beehole borer larva occurring in Shwebo division was found to pupate in August and emerge in that

month. This implies the utilisation by the parasite of an alternate host in which to pass the nine months which must elapse before larvae of the first host are again in the right stage for parasitisation, *i.e.*, a very young instar.

Defoliators.—Hapalia machaeralis. A sequence of thirteen generations in one year has been bred in the Pyinmana insectary. In the field the presence of *machaeralis* throughout the year was determined; from the beginning the population is considerably reduced, feeding taking place on coppice shoots and adventitious foliage.

Experiments to discover the cause of dominance of females in insectary rearings showed that (*i*) starvation did not affect the sex ratio; (*ii*) the viability of eggs of the bred strain and the wild strain was the same; (*iii*) larval mortality of the bred strain was not higher than that of the wild strain; (*iv*) dominance was not due to overcrowding; (*v*) a fresh series gave the same results, *i.e.*, after a few generations the preponderance of females was established; (*vi*) the effect of light and selection of eggs was negative. It seems probable that the particular strain of *machaeralis* occurring in Burma naturally tends to the dominance of females.

No cases of *machaeralis* on alternate food-plants were recorded in the field. In the insectary it was reared on *Callicarpa arborea* and *C. macrophylla* and on *Tectona hamiltoni*. *Plumeria acutifolia* was refused.

Hibernation in the prepupal stage (January to March) was observed at Pyinmana.

Information has been collected on the distribution of the parasites of teak defoliators in Burma.

An egg parasite, *Trichogramma* sp., readily parasitised eggs of *Ephestia* and *Sitotroga*. The technique of mass production of this parasite on *Ephestia* has been worked out. Three new larval parasites were recorded.

Hyblaea puera.—This species was not observed in the field between mid-December and the end of March but a complete sequence of generations was obtained in the Pyinmana Insectary. That hibernation takes place without appreciable diminution of numbers was confirmed by the abundance of this species early in the rains.

In addition to the fourteen food-plants other than teak one species of *Vitex* was added.

Three new species of pupal parasites were recorded and predators were studied.

Bamboo borers.—It has been shown conclusively that a degree of immunity to attack by *Dinoderus*, sufficient for practical purposes, results from submersion of not less than a month in either fresh or salt-water. *Dinoderus brevis* is the most prevalent species.

Calopepla leayana.—Four years observations show that heavy rainfall in May and August at the period of the young larval instar is destructive to the insect. Heavy rain in June or July does not kill off the insect which is then in the later larval, pupal and imaginal stages.

Control measures under trial include (*i*) collection of beetles by hand; 1·83 lakhs were destroyed in April-May and 1·47 lakhs in August; (*ii*) cutting *taungyas* round the margins of the affected plantations. Experiments are projected on the use of white surfaces for traps and artificial hibernation shelters, and spraying the trees in a marginal belt.

The pupal parasite *Brachymeria* and the egg parasite were studied and tests made of possible alternate hosts.

Xyleutes persona.—Emergence in March from caged and wild *Cassia fistula* was recorded.

The life-cycle lasted 26 to 30 months. The number of eggs laid by a female is 12,000 to 15,000.

CENTRAL PROVINCES.

Teak seedlings raised by the *rab* method in Yeotmal were damaged by larvae of *Lachnosterna*.

The *siris* (*Albizzia lebbek*) in the Pathrot agri-silvicultural plot was damaged by insects attacking its roots. In the Melghat young shoots of teak especially in areas with shallow and poor soil, where growth is naturally slow, are frequently affected by galls due to *Cecidomyidæ*.

The attack of *Celosterna scabrator* was bad in the coupes under regeneration in the Loni Babul Ban of the West Berar division. Roughly 35 per cent of the plants were found to be attacked.

The exposed wood of *Sterculia urens* was attacked by borers where it had been blazed by contractors. To avoid this departmental tapping was undertaken in Damoh with improved results.

The attack of the *sal* borer, *Hoplocerambyx spinicornis*, was mild and sporadic. Remedial measures by means of trap trees were prompt and effective.

The semal-bud-worm, *Tonica niviferana*, continued its ravages in the Chorbaoli *semal* plantation.

The teak leaf-defoliators *Hapalia machaeralis* and *Hyblaea puera* continued active, especially in Betul.

A kheddah was organised in the Bhongaon reserve of the West Berar division to catch wild cattle, which are doing a great deal of damage both to the forests and the adjoining cultivation. A funnel-shaped enclosure with three gates was constructed and drives organised to trap the cattle. 34 cattle were caught of which 4 escaped and 3 died. Of the remainder six were auctioned for Rs. 63. Owing to the apathy of

the local people this method of catching had to be abandoned and attempts were next made to catch the cattle in rope nets. Twenty-seven head of cattle were thus caught. The campaign will be continued during next cold weather.

Blue bull (*Boselaphas tragocamelus*), *chital* (*Cervus axis*) and bison (*Bos gaurus*) are doing considerable damage to plants, particularly *siris*, *sewan* and *nim* by browsing and barking the trees in some of the agri-silvicultural plots in the Yeotmal district. A *bhirra* sample plot in Hoshangabad division, which is now surrounded by clear felled coupes, has become a playground for *sambhar* (*Cervus unicolor*) with the result that every tree is barked upto 6′ by the rubbing of their horns.

Porcupines have extensively damaged young teak by ringing them at the base in the regenerated coupes of Bori range in Hoshangabad division.

PUNJAB.

Insect attack was again recorded this year in the bamboo forests of Karanpur and Sansarpur Ghati. The attack was a severe one, and resulted in loss of production of *manus*.

MADRAS.

The investigation by the Forest Entomologist, Dehra Dun, of the attacks by borers in the Beypore Depot, shows that the important marine borer in the Beypore river is *Martesia striata*, a pholad mollusc. A teredo also attacks timber in these waters, but is much less abundant than *Martesia*, which crowds it out and prevents its full development.

Remedies were advised indicating the periods during which logs can be safely handled in brackish water and the measures to be taken if fresh water storage for the whole year is required.

CHAPTER V.—UTILIZATION AND ECONOMIC RESEARCH.

ASSAM.

I.—General Work of Administration.

A proposal for the appointment of a Utilisation Officer was submitted during the year and has since been approved.

II.—Experimental and Commercial Activities.

(1) *Wood Technology.*

The report on the 36 specimens of *bonsum* (*Phœbe*) sent by the Botanical Officer to the Wood Technologist, Dehra Dun, last year was received as follows:—

"Results of the microscopic study of these samples show that the variation in the minute anatomy is within the limit of a species. That is, the anatomical differences are not marked enough to justify their classification into different species."

4 pieces of fossil wood specimens collected by Mr. Purkayastha from Dhansiri Reserve, Nowgong division, were sent to the Forest Economist, Dehra Dun, in October 1933 of which only one has been examined and named as *Glutoxylon assamica*.

Another specimen has been sent to the Wood Technologist recently from Jeypore.

(3) *Timber Testing.*

The Assam Oil Company is continuing the experiment with *ping* (*Cynometra polyandra*) as a substitute for imported hickory for vibratory screens as used in the oil wells at Digboi.

Cachar division has been able to export *gurjan* (*Dipterocarpus turbinatus*) to Calcutta for use as railway wagon bottom boards on a fairly large scale.

Hilika (*Terminalia chebula*) is being tried as a substitute for *hollock* (*Terminalia myriocarpa*) in Lakhimpur division for constructional work where the latter is not very plentiful. It has been arranged with the Forest Research Institute, Dehra Dun, to carry out the necessary tests on *hilika* (*Terminalia chebula*). *Artocarpus chaplasha* has been sent to Dehra Dun for test from Cachar division.

(4) *Wood Preservation.*

The Assam Oil Company is anxious to try *hollong* (*Dipterocarpus macrocarpus*) as a substitute for red cedar which they import from

America at considerable expense for the construction of cooling towers. They are now experimenting with the species after treatment by the open tank process. The result of the treatment will be of interest, for with the closing down of the treating plant at Naharkatiya the department has lost a good market. The question of reopening the plant is under negotiation.

(6) *Paper Pulp.*

The extraction of *muli* (*Melocanna bambusoides*) in Cachar for the purpose of paper pulp continued but in smaller quantities owing to competition from Bihar.

Grasses of Goalpara division were tested and found suitable for paper pulp but the extraction is not likely to be economical.

(8) *Wood Working.*

Extraction of *champa* (*Michelia champaca*) for export to Calcutta market from Goalpara division increased considerably and a regular market is now established for this species.

(9) *Miscellaneous.*

Mezankori (*Litsæa citrata*).—The plants are now 4 years' old. Silkworms were reared on them by the Sericulture department in October last. The caterpillars thrived well but towards the last part of October heavy casualties were noticed due to late rains.

Tung oil (*Aleurites fordii*).—Out of 27 plants surviving 2 died during the year and 3 looked unhealthy.

About a dozen of *jati* (*Bambusa tulda*) roots were supplied to Messrs. Uberoi Ltd. for testing for polo sticks but the reports were not very favourable.

Enquiries were received for the fibres and plants of *Villebrunia integrifolia* (*bon riha*) from Messrs. Begg Dunlop & Co. of Calcutta.

Five pounds of air dried roots of the climber *Derris elliptica* were sent to the Forest Research Institute from Nowgong division and the following reports were received :—

"The sample (18-24 months) from Nowgong appears to be a good sample of *Derris* and compares favourably with *Derris* from Federated Malaya States. The composition and rotenone content of *Derris elliptica* is very variable. Taking this factor into consideration the sample from

Nowgong may be classed as a good quality *Derris* and should be able to find a ready market. From roots ¼" to ⅜" diam. the moisture, ether, and rotenone per cent found in the air dried samples from Nowgong were 3·5, 4·5 and 2·4 respectively, as compared with 4·9, 4·5 and 0·93 per cent found in similar samples from Kuala Lumpur, F. M. S. For roots ⅜" 1" diam. from Nowgong the figures were 3·8, 2·7 and 0·8 respectively.

More samples have been asked for and will be sent for further examination. A sample of the roots of this climber was also sent from Goalpara division.

BENGAL.

I.—General Work of Administration.

Mr. T. M. Coffey, Deputy Conservator of Forests, held charge of the post of Forest Utilisation Officer throughout the year under report.

II.—Experimental Activities.

(1) *Timber seasoning.*

Ten tons of forest grown *toon* (*Cedrela toona*) logs were sent to the Forest Economist, Forest Research Institute, Dehra Dun, for kiln seasoning experiment under Project VII. A comparison was desired between forest grown and road side trees. Ten teak (*Tectona grandis*) trees were girdled during the year under report in compartment 33 and 34 (selecting felling coupe) of Sitapahar range in the Chittagong Hill Tracts division for seasoning experiment.

The following interim report on the *champak* (*Michelia excelsa*), planks supplied from Buxa division was received during the close of the year under report:—

> "The moisture content of the timber as received was very high ranging from approximately 92 to 147 per cent. Seasoning commenced on 10th September 1934 and was completed on 11th October 1934, by which time the moisture content was reduced from 7 to 9 per cent approximately. It was noticed on removal from the kiln that the charge of *champak* planks had twisted considerably during seasoning, 80 per cent of the total having warped badly. Four planks of *champak* and two planks of *toon* to act as a control were cut to the length of rifle chest and planed on all sides. These planks were sub-

jected to storage trials and deviations noted monthly, the result being recorded in the statement below."

Plank No.	Deviation.			
	8th November 1934.	8th December 1934.	14th January 1935.	12th February 1935.
Champ No. 1 . .	$\frac{1}{16}$" centre $\frac{1}{16}$" one end $\frac{1}{32}$" other end	No further deviation.		
Champ No. 2 . . .	$\frac{1}{32}$" warp	No further deviation.		
Champ No. 3 . . .	$\frac{1}{32}$" spring	No further deviation.		
Champ No. 4 . . .	$\frac{1}{8}$" centre and cross ends	$\frac{1}{8}$" centre $\frac{1}{32}$" cross ends } No further deviation.		
Toon No. 5 . . .	$\frac{1}{16}$" warping	$\frac{1}{8}$" warping. No further deviation.		
Toon No. 6 . . .	No deviation at all.			

(2) *Timber Testing.*

4 logs of each of *Cryptomeria japonica* and *Bucklandia populnea* from Darjeeling division and 4 logs of *Dipterocarpus turbinatus* from the Chittagong Hill Tracts division were supplied to the Forest Economist, Forest Research Institute, Dehra Dun, for veneer and plywood test under Project VIII during the year under report. No report is yet to hand. A further consignment of the following species was also sent for the same tests :—

From Darjeeling.—*Katus* (*Castanopsis hystrix*).

From Kurseong.—*Laurel* (*Terminalia tomentosa*) and *kadam* (*Anthocephalus cadamba*).

From Chittagong Hill Tracts.—*Chaplash* (*Artocarpus chaplasha*), *gumhar* (*Gmelina arborea*) *jarul* (*Lagerstræmia flos-reginæ*) and *champak* (*Michelia champaca*). Report not yet received.

As the Bengal Silviculturist is putting out a lot of *gokul* (*Ailanthus grandis*), 5 logs of the same were supplied to the Forest Economist, Forest Research Institute, Dehra Dun, to test under Project I. Report not received. To compare with *Grewia tiliafolia*, 5 logs of *Grewia vestita* were sent to the Forest Economist, Forest Research Institute, Dehra Dun, for testing under Project I from the Kurseong Forest division. No report has been received. 16 logs of *gumhar* (*Gmelina arborea*), *chaplash* (*Artocarpus chaplasha*), *gurjan* (*Dipterocarpus* spp.) and *champak*

(*Michelia champaca*) were sent to Dehra Dun, Forest Research Institute, from the Chittagong Hill Tracts division to test their quality with a view to the possibility of extending for their use outside Bengal. 5 logs with 5 discs from different positions in the tree (*Tectona grandis*) from Kurseong division and the same from Chittagong Hill Tracts division (the Chittagong Hill Tracts teak had been girdled) were sent to Dehra Dun, Forest Research Institute, for test and comparison. From Sundarbans division samples of *sundri* (*Heritiera minor*) were supplied to Messrs. Shevades Camera Works, Belgaum, and to the Superintendent, Presidency Jail, Alipore, to test suitability for their work.

Reports on *sundri* (*Heritiera minor*) hammer shafts and tool handles supplied to the Chief Mechanical Engineer, E. B. Railway, for test were unsatisfactory. 5 logs of *Dalbergia sissoo* were sent to the Forest Research Institute, Dehra Dun, from Jalpaiguri division, to compare it with Changa Manga sissoo. As Bengal sissoo has become important for ordnance work and may become important for export to Europe, it is being fully tested under Project I.

(5) *Minor Forest Products.*

At the request of the Controller of Stores, Indian Stores Department, New Delhi, one tin of gurjan oil was supplied to the Director of Industries, Bengal, from the Chittagong division to test its suitability for paints. Controller of Stores, G. I. P. Railway, reports that they are using bamboos for tool handles with as good or better results than with wooden handles, except possibly English ash. He made the following remarks on the Forest Economist's objections made in the previous year :—

> "Bamboo handles must never be shaped, as, quite apart from weakening effect, cutting of the outside fibres render bamboo useless for work due to the splinters which cannot be eliminated even by fine work."

Bamboos are used by the G. I. P. Railway mostly for sledge hammers. Four samples of *Dendrocalamus strictus* from Buxa division were supplied to the Controller of Purchase, Calcutta Circle, for testing its suitability for handles during the year under report. 6 samples of solid bamboos (*Dendrocalamus strictus*) were supplied to the E. B. Railway for testing its suitability for hammer handles. They decided that it was unsuitable without a trial.

(6) *Paper Pulp.*

(*a*) Samples of paper made from *Dendrocalamus hamiltonii* at the Forest Research Institute, Dehra Dun, were received and sent to the

Titaghur Paper Mills, Bengal Paper Mills Co., Ltd., and Indian Paper Mills. The paper was considered very good but we are unable to sell to the Mills this bamboo owing to the prohibitive cost of extraction and railway freight.

Three tons of *kaliserri* (*Oxytenanthera auriculata*) were sent from Chittagong Hill Tracts division to the Dehra Dun Forest Research Institute for semi-commercial tests.

(7) *Tans.*

No report is yet to hand on the 5 maunds of *goran* bark sent to Hamburg and Denmark through the Superintendent, Tanning Institute, Bengal.

(8) *Wood Working.*

Two B. G. and one M. G. sal sleepers were sent to Ceylon and Sudan for tests in their lines. No report is yet to hand. One log of *Holarrhena antidysenterica* was sent to Messrs. P. L. Dawn & Brothers, 6-A, Butto Kristo Lane, Calcutta, for the manufacture of umbrella handles. It proved successful but the cost of supplying the timber was too high and the order was cancelled. Sample squares of *saur* (*Betula spp.*) were supplied to the Gramophone Company, Dum Dum, and it resulted in orders. *Toon* (*Cedrela toona*) and *gamari* (*Gmelina arborea*) were supplied from the Buxa division to the Sundarbans division and were used for boat building as an experiment.

The following report from Messrs. F. N. Gooptu & Co., Calcutta, was received on *Cryptomeria* for pencils and *gumhar* (*Gmelina arborea*), *dhar* (*Bæhmeria rugulosa*), *haldu* (*Adina cordifolia*) for pen holders:—

"No other quality of wood, except *haldu* (*Adina cordifolia*) was found suitable for our work."

The following report on the working quality of *Alnus nepalensis* (air dried) sent from Darjeeling division was received during the year from the Forest Research Institute, Dehra Dun:—

> "This specimen worked to an exceptionally smooth and attractive finish with the greatest of ease. It was straight-grained, even-textured and free from knots or degrade of any kind. It machined and turned well to a smooth satin-like finish, the figure, in some parts, somewhat resembling that of quarter sawn oak.
>
> In short it was one of the most pleasing specimens in the matter of working up, which I have handled during my experience of Indian timbers.

If the specimen under review is representative of the timber in general it could be used for numerous purposes where excessive strength and hardness are not essential. It stains and polishes well and would be suitable for furniture, fitments, possibly radio and gramophone cabinets, match boarding, ceiling boards, partitions, etc.

Though I have not peeled this species, I give it as an opinion that it would make a plywood comparable in appearance and strength with the average imported plywood."

Report on the bobbins and spools made locally from local birch sent to the Director of Industries, Bengal, for test in the Jute Mills was received :—

"Betula wood offers no attractive possibilities to the Indian Textile Industry at present."

The following species were supplied to Messrs. Birla Jute Manufacturing Co., Ltd., Calcutta, from Darjeeling, Kurseong, Sundarbans and Chittagong Hill Tracts division, for testing their suitability in the manufacture for picker arms :—

Mulberry (*Morus laevigata*), *sissoo* (*Dalbergia sissoo*) *sundri* (*Heritiera spp.*) and *hollong* (*Dipterocarpus pilosus*). Final report on the picker arms has not been received.

Match Wood.

(*a*) As the Western India Match Co., Ltd., could not submit any report on *pipli* (*Bucklandia populnea*) for match manufacture due to a change of their staff, one new log was sent to them for test from Kalimpong division. The log was tested and has been recommended only for making inner and outer boxes if the logs are without knots and of a suitable diameter. The report on the sample of *mullata* (*Macaranga pustulata*) sent from Buxa division in the previous year for match manufacture received from the Calcutta Match Works was not satisfactory.

Box Planking.

Kadam (*Anthocephalus cadamba*) logs were found by Messrs. Mansfield & Sons, Calcutta, suitable for box planking and *maina* (*Tetrameles nudiflora*) and *udal* (*Sterculia villosa*) logs proved to be quite a good substitute for the same.

(9) *Miscellaneous.*

The following species collected last year for testing their suitability for hammer and tool handles were supplied to the Controller of Stores, E. B. Railway, to report their suitability for the purpose :—

Phalame (*Photinia integrifolia*)

Asare (*Viburnum erubescens*)

Buk (*Quercus lamellosa*)
Pipli (*Bucklandia populnea*)
Dar (*Bœhmeria rugulosa*)
Mundani (*Acrocarpus fraxinifolius*)
Birch (*Betula alnoides*)
Kimbu (*Morus lavigata*)
Chickrassy (*Chukrasia tabularis*)
Amoora (*Amoora wallichii*)
Solid bamboo (*Dendrocalamus strictus*)
Khair (*Acacia catechu*)
Sissoo (*Dalbergia sissoo*)
Safed siris (*Albizzia procera*)
Dhakijam (*Eugenia grandis*)
Botijam (*Eugenia operculata*)
Putijam (*Eugenia fruticosa*)
Kalajam (*Eugenia jambolana*)
Batna (*Quercus thomsoni*)
Range-batna (*Quercus spicata*)
Lata-batna (*Quercus acuminata*)
Girji-batna (*Quercus lanceæfolia*)
Dhali-batna (*Quercus polystachya*)
Gamari (*Gmelina arborea*)
Dhaman (*Grewia tiliæfolia*)
Mesua (*Mesua ferrea*)
Hollong (*Dipterocarpus pilosus*)
Sundri (*Heritiera minor*)
Amur (*Amoora cucullata*)
Horina (*Vitex peduncularis*)

BIHAR AND ORISSA.

Increased activity has necessitated the framing of a definite Utilisation Policy. This is—

(*a*) To extend to the utmost limit the exploitation and sale of the Province's forest products by :—

(i) endeavouring to enlarge the present circle of consumers by the introduction of new clients to contractors having stocks of timber, and

(ii) fostering the demand for our lesser known timbers by educating consumers into their uses.

(*b*) To study the methods of felling, conversion and extraction with a view to their improvement.

(*c*) To improve the quality of timber for sale by the introduction of grading rules with quality classes, thus encouraging contractors to market good material.

(*d*) To investigate all complaints of consumers regarding the quality of the goods sent.

(*e*) By demonstration to educate contractors into the necessity for seasoning carefully timbers known to be refractory and to call attention to the value of treating antiseptically timbers easily attacked by termites.

(*f*) To keep a close watch on rail freight in an endeavour to ensure that transport costs do not prevent exploitation or claim too large a share of the sale value.

Summary of Results.

A market for packing case timber was discovered in Bengal and in Jamshedpur by the Divisional Forest Officer, Saranda. To meet this demand enumerations are being carried out in the miscellaneous working circles of Saranda and Kolhan divisions, hitherto unworked. It is estimated that these two markets alone will absorb more than the available outturn. An excellent market for hardwood sleepers has been found in the Dhanbad Coal Field, the annual requirements of which is sufficient to absorb the whole of the estimated outturn of hardwoods of Saranda and Kolhan divisions should our quotation be successful. A ready market has been found with Messrs. Mansfield and Sons of Calcutta, for *simul* (*Bombax malabaricum*). This firm can take 500 tons a month, far more than we are ever likely to be able to supply. A thinning scheme for Saranda, Kolhan and Porahat divisions is being worked out. Simultaneously a large pole market is being uncovered in the coal fields and the Indian Copper Corporation which may absorb most if not all of the 1½ lakhs of poles which it is estimated that scheme will produce. A big market has been found for *salai* (*Boswellia serrata*) with the Indian Wire Products Ltd., Tatanagar, for the manufacture of kegs.

Africa, Mauritius, Egypt, Ceylon, and Singapur markets were investigated for *sal*. For quantity and strength it is considered equal if not superior to Australian jarrah, but transport costs are prohibitive. London market was tried for *laurel* (*Terminalia tomentosa*) and an order for two wagons from the High Commissioner has been received.

Results of tests on *Ougenia dalbergioides* and *Pterocarpus marsupium* for veneer and plywood are being awaited. Tests for the manufacture

of tool handles are being made at the Chief Mechanical Workshop, Kharagpur, B. N. Railway. Results of the tests on some inferior species for the manufacture of brush backs and broom handles for the Calcutta Corporation and the Railway by the Bengal Brush Factory are being awaited. From sample timbers sent to Messrs. F. N. Guptoo's pencil and pen factory at Calcutta, *Melia composita* and *Hymenodictyon excelsum* were selected as being suitable for further tests and more samples have been sent.

The effect of *Ascu* treatment on *sal* and laurel poles and soft wood is being tested out by "grave yard tests" at the Forest Office compound, Doranda. It is proposed to erect an antiseptic tank next year for treatment of poles by this method.

A few years ago an air seasoning shed was erected in Ranchi and results were successful. In order that the value of seasoning may be better realised, a seasoning shed is being erected in Kolhan division. Laurel (*Terminalia tomentosa*) and *karam* (*Adina cordifolia*) will be among the first species to be seasoned there.

The Dunlop Pneumatic tyred cart with ordinary bullocks is being tried departmentally in the casuarina plantation on the sands of Puri with success.

Floating.—Bamboo floating experiments have been carried on in Palamau, Saranda and Sambalpur West divisions with a new snake-like type of raft consisting of ten-twelve pairs of bundles tied head to tail to be used in rivers having stretches of rapids. The bamboos from the last named division sold at considerable profit in Sambalpur town. Timber floating in Saranda is under contemplation while the floating of *sal* poles from places distant from the railway station may solve the difficulties of transport costs. A floating experiment carried out in Kolhan division showed that *sal* poles felled and left lying in the forest for the month of February floated after full exposure to the sun for a further 29 days. Laurel (*Terminalia tomentosa*) required 11 days, *dhaura* (*Anogeissus latifolia*) 15 days and *karam* (*Adina cordifolia*) 23 days extra to the month. During the hot weather poles should become floatable at an even quicker rate.

Floating costs on the Mahanadi from Ramedega to Sambalpur 26 miles away are only annas 14 per 1,000 bamboos compared with Rs. 4 for carting over the same distance. The possibilities are considered to be so good that every effort should be made to develop them. The Indian Paper Pulp Co. at Naihati are interested in the experiment. The floating of timber and firewood is also considered feasible in this river and is so much cheaper that if adopted, demands for produce and consequently revenue, are bound to increase.

Match woods. Angul.—Specimen match wood logs were sent to the Talcher Match Factory and were satisfactorily converted to veneers. 500 trees as an experiment have been sold to them at 6 pies per c. ft.

Figured laurel (*Terminalia tomentosa*) logs were also sent for converting to veneers but were found to be too hard for the saws.

Lac.

Chaibassa.—In order to improve conservation of soil moisture in the Bichagutu lac orchard, *bogamedcloa* was sown after ploughing and is reported on favourably. Twenty *kusum* (*Schleichera trijuga*) trees were infected in the hope of providing sufficient brood lac and 1,760 *khair* (*Acacia catechu*) were pruned in March ready to receive the infection in July.

Santal Parganas.—An experiment with *ber* (*Zizyphus jujuba*) brood lac showed that it can be successfully infected on pruned (*khair*) trees. The crop on *khair* and *ber* was subsequently attacked by a predatory insect which is blamed for the low yield.

BURMA.

I.—General Work or Administration.

The post of Forest Economist was held by Mr. C. W. Scott, O.B.E., Deputy Conservator of Forests, from the 1st April 1934 to the 24th October 1934, and by Mr. M. N. Gallant for the rest of the year under report.

II.—Experimental Activities.

(1) *Wood Technology.*

Owing to the post of Forest Botanist being held in abeyance there were no additions during the year to the collection of timber specimens authenticated by botanical specimens from the same trees. Standard hand samples, $6'' \times 3'' \times \frac{1}{2}''$, of the more important economic timbers were supplied to various enquirers in Burma, India, United Kingdom and British Columbia.

Routine identifications were carried out for numerous enquirers, by hand lens examination at Rangoon, or by microscopic examination at Dehra Dun, to whom acknowledgments are due for the help given. Arrangements were made during the year to supply samples of Burma teak, $6'' \times 4'' \times 2''$, from all the major areas of supply to the Director, Forest Products Research Laboratory, England, with a view to study of variation of quality with locality. Two lessees supplied samples of

teak from their various forests and these were sent to Princes Risborough.

During the course of beehole analysis of 1" boards from plantation teak, it was observed that a pale variety of wood was frequently associated with the pith of trees from the drier parts of Burma. This " pale wood " was less common in trees from the wet zone. Samples of " pale wood " were sent to Dehra Dun for strength tests, but no appreciable difference in strength from ordinary teak wood was observed. It is proposed to continue observations on " pale wood " particularly in regard to its durability, resin content, resistance to termites, etc. Some " pale wood " boards have been put up at Ahlone to test their weathering qualities. Other tests will be carried out in conjunction with Dehra Dun as material accrues.

A final report was received during the year from the Wood Technologist, Dehra Dun, on the 91 teak specimens (6"×1"×1") sent to Dehra Dun for impact (brittleness) tests. The Wood Technologist's conclusions may be summarized as follows :—

Fast grown teak (*i.e.*, 1 to 4 rings per inch) is weak if light in weight or if heavy with gum deposits but is strong if heavy and without gum deposits. Medium grown teak (*i.e.*, 5 to 18 rings per inch) is moderately weak if light in weight but strong if heavy. Slow grown teak (*i.e.*, 19 rings per inch and over) is weak if light in weight but moderately strong if heavy. These conclusions are in the main similar to those set out in last year's report. As the original grading of the specimens into wide, medium and narrow ringed left something to be desired, it is proposed to continue the work on further, carefully graded specimens.

A further consignment of sound and unsound sole bars were sent to Dehra Dun for tests during the year. The report, received after the close of the year, showed all specimens to be weak and under strength, but as against this they were all of low specific gravity. None the less, it appears that they have suffered from being subjected to overstressing over prolonged periods.

(2) *Timber Seasoning.*

The five internal fan kilns gave satisfactory service throughout the year. The three large (6 ton) kilns dealt with the seasoning of 188 tons of *yon* (*Anogeissus acuminata*) and *kyana* (*Carapa moluccensis*), with the loss of 5 per cent only of possible working days. Fourteen tons of *kyana* (*Carapa moluccensis*) planks, *knaw* (*Adina cordifolia*) scantlings and teak flooring strips were put through the 75 c. ft. kiln, with the loss of 9 per cent of possible working days. The decreased efficiency of this kiln was due to a bad breakdown in the fan circulation equipment. Experimental runs on *yon* (*Anogeissus acuminata*) and *thitkado* (*Cedrela toona*) were put through the 5 c. ft. model kiln.

The quantity of timber kiln seasoned was higher than for the previous year, when 170 tons only were seasoned. As against this there was a further saving in fuel and total running costs which brought the cost of kiln seasoning down still further from Rs. 1-13-5 per c. ft. in 1933-34 to Rs. 1-8-6 per c. ft. in 1934-35, which is the lowest figure attained so far. This figure is particularly satisfactory when it is borne in mind that $\frac{3}{4}$rds of the timber dealt with was $2\frac{1}{2}$ inch thick; if the timber in the runs had been confined to 1" board, the seasoning charges could have been reduced to 10 annas per c. ft.

Teak flooring strips $\frac{1}{2}$ to 1 inch thickness were seasoned in the 75 c. ft. kiln. They were brought down from 48 per cent to 12 per cent moisture content in 12 days. None of the samples developed defects and the mild stresses developed during treatment were entirely removed in the final steaming. *Kyana* (*Carapa moluccensis*), *yon* (*Anogeissus acuminata*) and *hnaw* (*Adina cordifolia*) behaved well under treatment and there was little degrade. Experimental runs of *yon* in the 5 c. ft. kiln with frequent steamings gave promising results. The reconditioning experiments of badly collapsed *thitkado* (*Cedrela toona*) were continued. Steaming at a slightly higher temperature than hitherto (200° F. as against 192° F.) enabled the period of treatment to be reduced from 16 to 14 hours.

Air seasoning experiments were confined to observations on a number of *yon* (*Anogeissus acuminata*) stacks in the storage sheds. The piles were built up during the peak of the dry season, which is not conducive to the best results, particularly with so refractory a species as *yon*, and a fairly high degrade, due mainly to surface and side cracking, was experienced. The indications are that the safest way to handle this timber for air-seasoning is, green conversion during the rains, followed by stacking under shelter for slow drying. A report on the study of ventilation in air-seasoning sheds is being prepared.

A comprehensive note was prepared during the year by Seasoning Officer, Mr. H. Barber, on the kiln seasoning of laurel (*Terminalia tomentosa*). His method of operation and Schedule is produced below:—

> Preliminary steaming is necessary for laurel. This should be carried out with saturated air at 10° above the initial drying temperature given in the schedule, taking at least *six hours* to reach the required temperature. After this temperature has been maintained for *three hours* for every one inch of thickness, the temperature and the humidity should be lowered from saturation very gradually to the conditions specified in the schedule. Too rapid lowering of the humidity is liable to cause end and surface checking. The drying conditions should be established by the end of the first 24 hours after the steaming treatment.

The most critical stage in the drying period is that between the establishment of the initial drying conditions and the establishment of the next step in the schedule. The only safeguard against damage is very accurate control of the conditions at this stage. As the run progresses and when the moisture content of the timber reaches the fibre-saturation point, *i.e.*, about 35 per cent, the next change in the temperature conditions specified in the schedule should be carried out. It is necessary, however, before the actual change takes place, to give the timber another steaming treatment, the steaming temperature in this case being about 5° above the required conditions with the air still in the saturated condition. The duration of this steaming period should be from 1 to 3 hours. It is essential in this connection to determine first the severity of the stresses, from test samples, as this will enable the operator to judge the length of the steaming treatment required. These short steaming periods, as shown in the schedule, should be continued till the moisture content of the timber reaches 15 per cent. The method of operation is then altered and instead of the steaming treatments at saturation, steaming at high humidity should be adopted. The reason for this change is that the difference in moisture content between the inner and outer layers cannot be great at this stage and any tendency for the surface layers to absorb more moisture than is necessary would reverse the stress. The duration of the high humidity steaming treatment should be from 4 to 6 hours.

The advantages as compared with the ordinary drying process are :—

(1) Comparatively slight stresses are developed and these are easily relieved at the final steaming treatment.

(2) Degrade due to checking and splitting is very considerably reduced.

(3) The rate of drying is slightly accelerated.

(4) The shrinkage values recorded under this process are slightly less than those recorded under previous drying processes.

Internal fan kilns are recommended for seasoning laurel because they are economical and give better results and faster drying than other types of kiln. In Rangoon it has been found possible to dry 1" laurel boards from green to 12 per cent moisture content in 24 days in internal fan kilns.

Drying Schedule.

Stage of Drying.	Drying Conditions.		Steaming Conditions.	
	Temperature of dry bulb.	Humidity.	Temperature of dry bulb.	Humidity.
	F.°	Per cent.	F.°	Per cent.
Initial	115	85	125	100
At 35 per cent. moisture content	120	80	125	100
At 30 „ „ .	125	75	130	100
At 25 „ „ .	130	70	135	100
At 20 „ „ .	135	65	140	100
At 15 „ „ .	140	60	145	85
At 10 „ „ .	145	55	150	80

The kiln dried material has been used in the workshop for manufacture of furniture and the behaviour of the finished articles has proved definitely better than those made from laurel seasoned by older methods.

Detail of a new process of kiln drying developed by Dr. S. N. Kapur, Seasoning Officer, Dehra Dun, was received during the year. It is proposed to make arrangements to test out the method during the ensuing year. Observations are being continued on the seasonal variations in moisture content of various species.

Various enquiries were dealt with in connection with the moisture content of timber and in particular teak. Complaints were received by lessees from the United Kingdom of excessive 'wetness' of teak and a note was written demonstrating the improbability of there being any difference between the moisture content of teak reaching a United Kingdom port now and 10 years back. Moisture content tests on small teak blocks showed that a moisture content of over 60 per cent was not unusual in freshly cut teak and that rough estimates of moisture content by feel and weight were unreliable.

(3) *Timber Strength Testing.*

Sample logs of the following species were sent to Dehra Dun during the year for routine tests :—

Under Project I—Tests on small clear specimens.

Taukkyan (*Terminalia tomentosa*).
Letpan (*Bombax malabaricum*).
Sawbya (*Sterculia campanulata*).

Under Project II—Tests on structural sizes.

Taukkyan (*Terminalia tomentosa*).

Under Project VIII—Plywood and veneer tests.

Kanyin (*Dipterocarpus alatus*) from Lower Burma.

Kanyin (*Dipterocarpus turbinatus*) from Upper Burma.

In or *eng* (*Dipterocarpus tuberculatus*).

Padauk (*Pterocarpus macrocarpus*).

Hnaw (*Adina cordifolia*).

Thitka (*Pentace burmanica*).

Pyinma (*Lagerstræmia flos-reginæ*).

Teak (*Tectona grandis*).

Some fresh *thitmin* (*Podocarpus wallichianus*) logs from Tavoy were collected during the dry weather. They were immediately converted and kilned soon after the close of the year and are to provide fungus free material for test at Dehra Dun.

(4) *Wood Preservation.*

Tests were started during the year on the efficacy of four preservatives supplied for protecting wood against destructive agencies such as decay, white ant and other insect attack, etc. Strips $\frac{1}{8}$" thick of *in-kanyin* (*Dipterocarpus* spp.), *mau-lettan-she* (*Anthocephalus cadamba*), and *taungthayet* (*Swintonia floribunda*) were treated with the various preservatives and placed with control strips of untreated and creosoted wood in white ant infected ground. Inspection at the close of the year showed that a few of the strips, some treated, showed slight signs of rot and white ant attack. The tests are still in progress.

Fire-proofing tests.

The merits of a fire-proofing compound were tested out roughly on teak, *in* (*Dipterocarpus tuberculatus*) and *kanyin* (*D. alatus*). Simple painting of wood with the compound did not appear to confer any appreciable degree of protection from fire. Further tests are contemplated. A suitable technique for these tests has still to be evolved.

(5) *Minor Forest Produce.*

Discussion with Messrs. Steel Bros., made it apparent that there would be no advantage in the export of lac from jungle to Rangoon in other than its raw form. The saving in freight consequent on the reduction in weight of raw lac after cleaning into stick lac would not compensate for the trouble of cleaning and sizing at up-country centres. Con-

version to seed lac requires plant and there are difficulties in transport of the product. It was decided that the only practical method of assisting the jungle end of the industry was by encouraging the production of lac of better (*i.e.*, lighter coloured) quality which should be attainable by concentrating on good hosts such as *gyo* (*Schleichera trijuga*), *yindaik* (*Dalbergia cultrata*) and *pauk* (*Butea frondosa*) and by exporting lac derived from such hosts unmixed with that from other species. To this end samples of *gyo* and *yindaik* (*Dalbergia cultrata*) lac were sent to Messrs. Steel Bros., who reported favourably on the *yindaik* lac. Unfortunately, this *yindaik* lac seems unprocurable in trade quantities.

The Crop Statistician of the Indian Lac Research Institute, Namkum, toured in Burma as in previous years for a fortnight in January 1935 to collect information on the Burma lac crop.

During the year 3 lbs. of fresh *Lalaw* seed (*Taraktogenos kurzii*) were sent to the Secretary, Forestry Board, Brisbane, for experimental work. Bark and latex of *Holarrhena antidysenterica* and *Alstonia scholaris* were sent for chemical analysis to the Chemistry Department of the Rangoon University.

An enquiry was made into the possibility of commercial collection of *Litsea* berries for candle manufacture. Samples are being arranged for.

One and quarter lbs. of nuts of young (1-3 years) *Aleurites fordii* grown at Taunggyi, Federated Shan States, were sent to the Imperial Institute, London, for analysis of the oil content. The oil from these nuts was found abnormal in the sense that it was comparable to that ordinarily obtained from *A. montana* (see table below). It is possible that the abnormality of the Taunggyi oil is accounted for by the fact that the seed was collected from very young trees, though it appears that even when allowance is made for the youth of the trees, the sample was none the less abnormal.

	Taunggyi *fordii*.	Average *fordii*.	Average *montana*.
Refractory Index nD 25°C. . . .	1·5143	1·5178	1·5146
Density 25° C.	0·9343	0 9356	0 9338
Time of gelation	11·75	9 5	11·5
Extract per cent.	29 1	21·8	26 8
Iodine Value per cent. . . .	162·4	165·6	163·7

A second sample of Taunggyi *Aleurites fordii* seed (both fruit and nuts) was sent to Kew for further tests during the year. Results are not yet to hand.

The usual number of miscellaneous enquiries for various minor forest products was received and answered.

(6) *Paper Pulp.*

There were no further developments during the year in regard to the exploitation of bamboo pulp. Data is still being collected from bamboo sample plots in Tavoy, Mergui, Arakan and Bassein. The Tavoy plots were inspected in detail during the year and the conclusion formed was that early rains felling of half clumps gives the most promising results. It was decided to recast the Tavoy and Mergui plots on somewhat modified lines and the recording of information in regard to these plots will in future be handled by the Silviculturist. The sample plot of *kayin* (*Melocanna bambusoides*) bamboo in Bassein division, clear-felled in 1930, was re-counted at the close of the year. The plot seems to be recovering nicely, though the bamboo is still on the small side.

(7) *Wood Working.*

As great a restraint as possible was put on expenditure throughout the year in pursuance of the need for economy.

The Government sawmill remained closed throughout the year for economy, the machines being greased and cleaned periodically. Supplies of timber were maintained from the flitches purchased last year and from logs bought and converted into flitch at Messrs. Foucar's sawmill during the year. Three hundred and seventy six tons of hardwood logs other than teak were purchased during the year and 12 tons of bee-hole research teak were received. Three hundred and thirty tons of hardwoods and 30 tons of teak were sawn to flitch at Messrs. Foucar's sawmill. Loss on rough conversion of hardwoods was 12·1 per cent. and of teak 40 per cent. The high loss with the teak is due to the fact that the logs were of small girth from young plantations. The hardwood conversion losses include *pagas* which were not measured but which were actually converted later into blanks for small hammer handles. Five hundred and twenty four tons of hardwood flitch and 81 tons of teak (bee-hole) flitch were cut to size on the frame saw. Conversion loss was low—13·6 per cent only.

The tonnage and value of converted timber charged on the job cards of the year was 204 tons of non-furniture wood valued at Rs. 29,239 and 15 tons of furniture wood valued at Rs. 3,145. There has been a drop in consumption of furniture wood and a great increase in consumption of non-furniture wood as compared with last year. Altogether 32 different species were handled in the workshop. Major attention was

given to the following, which are arranged in descending order in regard to the amount of work done on them :—

Constructional—

Thingan (*Hopea odorata*).

Industrial—

Yon (*Anogeissus acuminata*) for hammer handles.

Mau (*Anthocephalus cadamba*) for boxes.

Hnaw (*Adina cordifolia*) for mounting blocks and bobbins.

Taungthayet (*Swintonia floribunda*) for packing cases.

Yemane (*Gmelina arborea*).

Binga (*Mitragyna diversifolia*) for mounting blocks.

Thitmin (*Podocarpus wallichianus*) for boat hooks, masts, etc.

Furniture—

Kyana (*Carapa moluccensis*).

Yinma (*Chukrasia tabularis*).

Taukkyan (*Terminalia tomentosa*).

Padauk (*Pterocarpus macrocarpus*).

Thitkado (*Cedrela toona*).

Sit (*Albizzia procera*).

Work was also done on the following species :—*Ananma* (*Fagræa fragrans*), *tamalan* (*Dalbergia oliveri*), *pyinkado* (*Xylia dolabriformis*), *aukchinza-ni* (*Amoora wallichii*), *banatha* (*Strombosia javanica*), *thitka* (*Pentace burmanica*), *manauga* (*Carallia lucida*), *sagawa* (*Michelia champaca*), *thingadu* (*Parashorea stellata*), *thinwin* (*Millettia pendula*), *sandawa* (*Cordia fragrantissima*), *chay* (*Gluta tavoyana*), *kaunghmu* (*Anisoptera glabra*), teak (*Tectona grandis*), *pyinma* (*Lagerstramia flos-reginæ*), *kyilan* (*Shorea assamica*) and *kanyin* (*Dipterocarpus* spp.).

The development of *yon* (*Anogeissus acuminata*) timber for handles was continued by the Timber Research Division during the year under report with great success. The demand for handles by the Indian Railways again exceeded the capability of the workshop to supply. Orders had to be refused as the supply of seasoned timber was limited to kiln capacity. The *yon* handles gave satisfaction except in the case of coupling poles for the Southern Railway in England. Samples sent failed under the very rigorous tests applied and work is being contemplated on young coppiced *yon* to determine whether it is more satisfactory than mature timber. A further consignment of tool handles for the same Railway is still under test and it is hoped that a demand for *yon* in England will be induced. *Hnaw* (*Adina cordifolia*) and *binga* (*Mitragyna diversifolia*) for mounting blocks have been in continued demand throughout the year and *hnaw* for cotton bobbins was in demand to an extent which could not be met

owing to lack of seasoned timber. *Mau* (*Anthocephalus cadamba*) and *taungthayet* (*Swintonia floribunda*) for box wood and packing cases, *panga* (*Terminalia chebula*) for sucker rod protectors and *thitmin* (*Podocarpus wallichianus*) for ladder and boat hook staves were in demand during the year. The ornamental woods, *kyana* (*Carapa moluccensis*), *yinma* (*Chukrasia tabularis*), *taukkyan* (*Terminalia tomentosa*), *sit* (*Albizzia procera*), *thitkado* (*Cedrela toona*) were all used for furniture during the year and little complaint was received concerning their behaviour. *Kyana* (*Carapa moluccensis*) proved somewhat disappointing in that for an order for 60 tons of seasoned board of various sizes that had been placed, only 36 tons of timber to size could be supplied from a purchase of 200 tons of flitches. This was due to cracking of the flitches. The timber actually supplied was so satisfactory as to lead to the demand for steady supplies of green timber, which was passed on to outside agencies.

An attempt which was made to assess the relative ease of planing teak at various moisture contents led to inconclusive results. It would appear that, allowing for the fact that flat grain boards are more difficult than open grain boards, the drier the board the more difficult it is to plane. Boards returned from Liverpool appeared to be slightly more difficult than local boards at the same moisture content. These Liverpool boards worked up darker and more oily than the fresher local boards.

(8) *Miscellaneous.*

(1) *Efforts to increase the sale of Burma timbers.*—Government, after careful consideration, decided against the recommendation of the Burma Retrenchment Committee to close down the Timber Research division, and, in doing so, enunciated the future policy of the division, which follows closely that described in the note reproduced in full in last year's report on the past and future policy of the Timber Research division. The main work is to be research into timber, the kilns are to research into seasoning problems rather than be concerned mainly with supply of seasoned timber to the workshop. Teak is to receive considerable attention and there should be adequate publication of results and liaison with teak lessees, traders and consumers in the attempt to foster extended sales of Burma timbers in export markets. The programme of work in the Timber Research division during the year was circumscribed largely by existing timber stocks, contracts and commitments, though voice was given where possible to the new policy. The ensuing year will see major attention being paid to problems connected with teak, *in-kanyin* (*Dipterocarpus* spp.) and *pyinkado* (*Xylia dolabriformis*) and the marketing of bulk woods.

Considerable efforts were made to bring the merits of teak to the notice of the trade and the public in general. A note on the durability of teak with special photographs of teak buildings in Burma was prepared

and sent to the Director of Forest Products Research Laboratory, Princes Risborough and to the Timber Adviser to the High Commissioner for India, London, for the purpose of advertising teak. A note on the marketing of Burma and Indian timbers, with special reference to the great merits of teak in Railway Coach construction, was published in the " Statesman ". Various other notes on teak were issued from time to time to lessees and others.

The Timber Research division made furniture and other articles out of teak supplied by the lessees for display at the British Industries Fair, 1935, and a note was prepared for propaganda purposes. A sample consignment of teak posts for telegraph poles was sent to Calcutta. Towards the close of the year, there were indications, given favourable prices, of more extended use of teak for telegraph poles in place of metal poles. There was a welcome reminder that metal has by no means all the say now-a-days in the enquiry received for teak " sockets " or feet for metal poles in N.-W. India.

The work on the grading of teak squares for the India market was brought to a conclusion after a series of discussions between Mr. L. N. Seaman, Officer-in-charge, Timber Testing Section, Dehra Dun, Mr. C. W. Scott, Timber Advisory Officer, Army and Railway Departments, the lessees and the Utilization Circle. The data, recorded by three Assistant Conservators of Forests on special duty, on defects and their relation to current grading systems amongst lessees were worked up by Mr. Seaman, who was thereby able to demonstrate the definite correlation between existing grades and the feasibility of a standard set of grading rules. A set of rules was finally evolved, which is now in Dehra Dun awaiting publication. These rules, the first of their kind to be developed for Burma timbers, will naturally be very much under test to begin with and may require modification from time to time, but a step in the right direction has been made that should assist materially in the further development of the teak market. In view of the growing competition from metal and other substitutes, it seems merely a matter of time before the standard grading system is applied to all teak and other Burma timbers. The teak trade and the Burma Forest Department are greatly indebted to Mr. Seaman for the laborious work undertaken by him in connection with the evolution of a satisfactory standard set of grading rules.

An order for 10,000 B. G. *pyinkado* (*Xylia dolabriformis*) sleepers was placed through the Utilization Circle for the North Western Railway, Karachi. The order was divided amongst two contractors and satisfactorily completed. The bulk of these sleepers were supplied from the Pegu Yomas and the remainder from Moulmein. The Pegu Yoma sleepers were the superior and were paid for at a somewhat higher rate. This order is a gratifying development of the work done last year in the

placing of a test order of 1,100 special size *pyinkado* sleepers for the North Western Railway. A further large order was placed through the Utilization Circle after the close of the year and the indications are that *pyinkado* has found an assured place in an extensive market with every prospect of further development. *Pyinkado* is indisputably the best of the untreated sleeper woods available in India and it is price only that controls its distribution. It is available in large quantities and it is in the interests of all parties concerned in Burma to keep prices down as far as possible in the effort to secure new, extensive markets.

The growing popularity of *yon* (*Anogeissus acuminata*) for hammer handles was most marked during the year and is a direct outcome of the work of the Timber Research division. The situation that has now developed is that complaints are received that sufficient supplies are not forthcoming. The two Indian railways for whom orders were undertaken pressed for further supplies and the orders of three other railways had to be turned down owing to lack of seasoning facilities. Proposals were put forward soon after the close of the year by the East Indian Railway to purchase green *yon* (*Anogeissus acuminata*) from Burma and to season and fashion it into handles for general supply to any Indian Railways willing to co-operate. Should these proposals materialise, the work of the Timber Research division on *yon* during the past 10 years and the large scale production of handles in 1932-35 will be amply justified. The inference is clear, that market development, which may necessitate large scale workshop production, is an integral part of timber research. Had it not been for the large scale production of handles by the Timber Research division, *yon* could never have attained its present position. It was necessary to demonstrate in practical manner the possibilities of the wood as inferred from service and laboratory tests before its position could be established.

A similar state of affairs obtains with *kyana* (*Carapa moluccensis*) which was supplied to the Gramaphone Co., Calcutta. A definite demand has been induced for green timber on a considerable scale. It remains to be seen if private enterprise will take up the supply.

Owing to the very much reduced budget of the Timber Research division, a number of enquiries for Burma timber, that promised new markets, had to be turned down. Instances are given below of orders that had to be turned down for lack of air-seasoned stocks :—

Taukkyan (*Terminalia tomentosa*) planks (20 tons) for England.
Yon (*Anogeissus acuminata*) tool handles for three Indian Railways.
Binga (*Mitragyna diversifolia*) (40 tons per month) for the Mills Stores Company.
Thitkado (*Cedrela toona*) (30 tons) for Messrs. George Richardson & Son, Calcutta.

It is regrettable that the Timber Research division is no longer in a position to meet promising demands of this sort for timber that can be produced in bulk.

Efforts to market *in-kanyin* (*Dipterocarpus* spp.) in London did not materialise owing to the dullness in the demand there. Shortage of funds, among other reasons, precluded a trial shipment. The usual display of Burma timbers was made at the Arts, Crafts and Industrial Exhibition held at Rangoon in February 1935 and a descriptive article was supplied for the Exhibition Guide Book. The regulation of the supply of match woods to factories, referred to in last year's report, was under examination during the year.

(2) *Comparative counts of "beeholes" made by the moth Xyleutes (Duomitus) ceramicus in teak from various localities.*—The count of beeholed teak boards from plantations was almost completed by Mr. C. W. Scott, when he was transferred to India. Mr. D. J. Atkinson, Forest Entomologist, who counted the remaining boards will be producing a comprehensive note on all work done in due course. The conclusions set out in last year's report have been further substantiated by the further work done.

(3) *Departmental Export of Burma Timbers.*—Shortage of funds stopped all departmental export of timber other than the teak supplied to the British Admiralty by the Depôt and Agency division.

(4) *Timber Passing.*—The only major passing during the year was on behalf of the North Western Railway, Karachi, who placed an order for 10,000 B. G. *pyinkado* (*Xylia dolabriformis*) sleepers through the Utilization Circle. There were considerable rejections of sleepers offered at Moulmein and at certain Prome line stations. Quantities of Pegu Yoma sleepers were offered at Rangoon and at Yeni, on the Pyinmana line; rejections amongst these Pegu Yoma sleepers were very small. Forty-six teak squares under shipment to Calcutta by Messrs. Steel Bros., were inspected and a passing certificate issued. A consignment of teak shingles under shipment to Port Blair by Messrs. The Bombay Burma Trading Corporation, Ltd., were also inspected and certified.

(5) *Wood Fuel for the Burma Railways.*—The scheme for supply of wood fuel for the Burma Railways mentioned in paragraph 99 of last year's report was accepted by Government. The Railways now furnish a list showing their annual fuel requirements at various stations and they are given a statement of possible sources of supply which is reproduced in their annual call for tenders.

(6) *Attack on Bamboo dunnage by Dinoderus.*—Experiments indicate the immunity from attack by *Dinoderus* on bamboos that have been soaked in water. Soaking in fresh, preferably, or in still salt water for about six weeks confers a reasonable immunity from attack, but soaking

in brackish running water is contra-indicated owing to attack by teredo. These experiments were initiated by the Forest Entomologist, following the observation of slight *Dinoderus* attack on teak, which was clearly due to defective dunnage. A detailed report is under preparation by the Forest Entomologist.

(7) *Enquiries and Liaison.*—Miscellaneous enquiries were answered on timber, fuel, charcoal, bamboos, lac, cutch, *tung* oil, etc. The usual liaison was maintained with other specialists in Burma, and at the Forest Research Institute, Dehra Dun; also with the Forest Products Research Laboratory, Princes Risborough, England, Imperial Institute, London, Royal Botanic Gardens, Kew, Timber Advisory Officer with the Railway Board, Delhi, and the Timber Adviser to the High Commissioner for India, London. Acknowledgments are due for help from all these sources. Technical Bulletins, Journals and other publications were received from Britain, America, Australia, Africa, French Indo-China and the Philippines and elsewhere. Fossils of Burma *Dipterocarps—ingyinkyauk* were sent to Dr. H. Bancroft of the Imperial Forestry Institute, Oxford, for comparison with the fossils of *Dipterocarps* from East Africa.

The Revised Edition of Rodger's Hand-book of the Forest Products of Burma was sent to press for publication during the year.

CENTRAL PROVINCES.

I.—General Work of Administration.

Mr. Abdus Salam, Extra Assistant Conservator of Forests, held charge of the Utilization Office from the beginning of the year until the 4th January 1935, when he handed over charge to Mr. I. J. Sharma, Extra Assistant Conservator of Forests, who remained in charge for the rest of the year.

Minor Forest Products.

Lac.—Owing to adverse climatic conditions the yield dropped down to about 40 per cent of that of the previous year. The total quantity of lac collected in 1934-35 was 1,250 maunds compared with 2,862 maunds in 1933-34.

The T. N. prices continued to rise till they reached Rs. 56 per maund in the month of July after which they gradually declined to Rs. 35 at the close of the year. This drop in the prices is reflected in the revenue obtained which amounted to Rs. 20,206 as against Rs. 54,482 last year.

Rusa grass.—The Rusa oil industry has been so hard hit by synthetic substitutes that the trade is now only of local importance. The present price is about Rs. 6 per seer compared with Rs. 16 a few years ago.

Tendu leaves.—Dullness of the *bidi* market is primarily responsible for the fall in receipts from the sale of leaves. The former is attributed to the advent of cheap cigarettes made in the country, which are gradually gaining favour amongst all classes.

Gum kureya.—The demand for this product of *kulu* (*Sterculia urens*) is steadily on the increase, and during the year, 59.291 cwt. of it were exported to foreign markets. Tapping done by the contractors was found very injurious to trees and therefore in Damoh this work was done departmentally during the year. This change led to a net profit of about Rs. 1,500 which is 100 per cent more than the contractors were prepared to offer. An interesting note on the best method of tapping the tree was published in the Indian Forester for March 1935.

Katha.—Though the slump is still continuing, leases for boiling *katha* were taken out in several divisions. The revenue obtained from this source was Rs. 7,901 compared with Rs. 18,323 in the previous year.

Paper pulp.—The right to collect *sabai* (*Ischaemum angustifolium*) grass from the Jubbulpore division was leased out for Rs. 575.

Harra (fruit of *Terminalia chebula*).—The yield was small compared with the previous year and the prices continued to decline till September 1934, after which they appreciated slightly as shown below :—

Quality.	Price per maund.					
	March 1933.	March 1934.	July 1934.	September 1934.	December 1934.	March 1935.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1. Jubbulpore Average . .	1 14 0	1 10 0	1 5 0	1 4 0	1 7 0	1 5 0
2. Jubbulpore No. 1 . .	2 6 0	2 0 0	1 10 0	1 8 0	1 11 0	1 10 0
3. Crushed No. 1 . . .	2 6 0	2 15 0	2 8 0	2 6 0	2 5 0	2 6 0

Wood working.—Attempts to popularise the use of pit and frame saws were continued in the Melghat, Nimar and Hoshangabad divisions. Over 13,000 c.ft. of sawn timber were brought to the depôts for sale. Contractors in Betul also followed the lead given by the department and they are now sawing the standard sizes most in demand in Khandesh and Rajputana.

Miscellaneous.

(*a*) *Suriya* (*Xylia xylocarpa*).—For the first time a small order for this species for making keys for metal railway sleepers was received from the Nizam's State Railways and the greatest care was taken to supply the consignment from South Chanda. The results were very satisfactory and it is hoped that furher orders will be placed by railways for this wood.

(*b*) *Salai* (*Boswellia serrata*).—The Eastern Group, Sleeper Control, Calcutta, have been supplied with a small quantity of salai wood from the Raipur division for testing its suitability for making coffins.

(*c*) *Pit props.*—A small quantity of sal and teak poles was supplied to the collieries at Parasia and Ballarshah. The consignment was considered very satisfactory and fresh orders for further supplies have been received.

(*d*) *Sal scantlings.*—The demand for sal scantlings is steadily on the increase.

(*e*) *Bamboos.*—Departmental collection and sales of bamboos were extended to the Bilaspur division. The total revenue realised by these operations was Rs. 20,173 against Rs. 6,972 in the preceding year.

(*f*) *Charcoal.*—Conversion of wood into charcoal is steadily increasing in forests in the vicinity of important consuming centres, and near railheads. Very satisfactory conditions are reported from Nagpur-Wardha, Melghat, Betul and Hoshangabad divisions. The increase in the use of saws by contractors and the expanding practice of making charcoal are indications that there has been some progress in the exploitation of coupes.

MADRAS.

I.—General Work of Administration.

The Forest Utilization Officer continued to organize the sales of logs, sleepers and Minor Forest Produce and was in charge of the disposal of timber in the chief timber producing divisions which are Coimbatore South, Nilambur and the Wynaad.

II.—Experimental and Commercial Activities.

(i) *Timber Testing.*—Most of the timbers due for supply for test under Projects I, II and VIII during 1933-34 were not actually despatched until 1934-35. As the Forest Economist, Dehra Dun, stated that he had sufficient timbers on hand, no supply was arranged for 1935-36. The results of tests made under Project VIII of some of the Madras timbers despatched during the previous years have been published in the Indian Forest Records, Vol. XX, Part XIV.

(ii) *Sleeper Tests.*—Joint inspection of the following treated and untreated experimental sleepers was made during the year, besides untreated sleepers on test lengths in the Broad Gauge, Meter Gauge, and Nilgiris sections of the South Indian Railway.

Treated.—*Cullenia excelsa.*
Eugenia gardneri.
Dipterocarpus indicus.
Poeciloneuron indicum.

Untreated.—Rosewood.
Eugenia gardneri.
Poeciloneuron indicum.

Test lengths.—*Hopea parviflora.*
Xylia xylocarpa.
Mesua ferrea.
Terminalia tomentosa.

(iii) *Matchwoods.*—A supply of 1,500 c.ft. of *Valeria indica* was made to the Western India Match Company from Mangalore South division for experiment. The Company have since reported that the logs are unsuitable for splints, because of their large dark-coloured core, and for boxes as they are of too coarse quality.

About 260 c.ft. of the following softwoods from Kurnool East division was sent to the Western India Match Company to test their suitability for match woods ;

Givotia rottleriformis

Sterculia urens

Gyrocarpus jacquini

These species have been reported by the firm to be too brittle. The test of *Garcinia spicata* from Nellore division for match manufacture was dropped, as this species does not attain the minimum specified size, viz., not less than 36 inches in girth at the thin end and not more than 90 inches at the thick end.

Commercial activities.—Sleepers. Only 1,702 B. G. *Hopea* sleepers were supplied to the Chief Engineer, South Indian Railway, at Rs. 6 per sleeper during this year, as the Sleeper Pool did not accept our tender owing to the reduced competitive rates tendered by private contractors. Besides 9,000 M. G. teak sleepers were supplied to the South Indian Railway at Rs. 3 and Rs. 3-8 per sleeper valued at Rs. 31,000.

Special sized Teak Sleepers.—Supply of 17,501 teak sleepers (56,581 c.ft.) valued at Rs. 1,82,495 was made to the South Indian Railway. It is gratifying to note that a further contract for two years from April 1935 has been accepted by the Railways.

(i) *Track sleepers.*—The Railways have since accepted a three years contract for the supply of 30,000 B. G. and 17,000 M. G. sleepers of *Hopea, Xylia* and *Mesua* each year from 1935-36 at Rs. 6 per B. G. and Rs. 2-12 per M. G.

(ii) *Bolted sleepers.*—The report up to February 1935 on the behaviour of 1,000 bolted sleepers of *Hopea, Mesua* and *Xylia* supplied to the M. & S. M. Railway for experiment shows that only ·08 per cent and ·71 per cent of the sleepers developed splits at both ends. The percentage of splits at one end varied from 3·59 to 11·11.

(iii) About 125 tons (6,270 c.ft.) of teak were supplied to the M. & S. M. Railway at Rs. 144 per ton f.o.r. Bangalore. About 80 tons (4,014 c.ft.) were also supplied to the South Indian Railway at Rs. 145-5 per ton f.o.r. Feroke and Pollachi. Negotiations were also made for the supply of benteak (*Lagerstroemia lanceolata*) to the South Indian Railway, and supply was effected in the following year.

(iv) As was already pointed out in the last year's report, the requirements of Public Works Department and Jails were mostly in the form of scantlings and planks, which the Department tried to supply through the agency of a private contractor from logs supplied by the Government. This arrangement proved to be unworkable due to the contractor's inability to keep up to the standard of quality required by the Jails, and the Department had to confine itself to the sale of timber in logs. Orders from the Public Works Department and Jails for about 6,580 c.ft. of teak logs valued at Rs. 14,247 were received and complied with.

(v) *Special orders and overseas trade.*—A small quantity of *Grewia tiliaefolia* was supplied to the Buckingham and Carnatic Mill at Rs. 1-8 per c.ft. f.o.r. Pollachi: Samples of white cedar and *Hopea* were sent to some firms in Bombay for special purposes. There were no oversea sales.

(vi) *Sandalwood.*—Retail sales of sandalwood for *bona fide* domestic use and for temple use were extended to Madras city and there was a great demand for it. Within a short period of about 3 months Qrs. 50-20-10 valued at Rs. 726 had been sold and there is still a fair demand.

(vii) *Timber Market.*—The market did not show any sign of improvement; most of the demand was for teak, and for other species in the descendant order of *Dalbergia latifolia* (rosewood), *Terminalia tomentosa* (laurel), *Xylia xylocarpa* (irul, mostly for sleepers), *Lagerstroemia lanceolata* (benteak), *Pterocarpus marsupium* (bijasal), *Terminalia paniculata* (kindal), *Grewia tiliaefolia* (dhaman) and other miscellaneous species. The rate for good quality teak and rosewood ranged from about Rs. 1-8 to Rs. 3 per c.ft. and for other miscellaneous species from Re. 0-12-0 to Re. 1-4-0 per c.ft.

The total value of sales made by the Forest Utilization Officer during the year amounts to Rs. 5,47,843.

Liaison.—The usual liaison with the Forest Research Institute, Dehra Dun and the Timber Adviser, London, was maintained.

Minor Forest Products.

Nux vomica.—The demand for *Nux vomica* was mainly for export purposes. About 500 candies were sold in April 1935 from the Nellore

division at Rs. 16-10 per candy of 500 lbs. and the rate realised was higher than the rate of Rs. 11-4 realised in the previous year.

Tans.—The demand for indigenous tan barks of *Cassia auriculata* and *Cassia fistula* was below normal, owing to the large import of South African wattle bark at cheap rates.

The results of examination of *Cassia auriculata* bark from the experimental plantations in the Nellore division were received from the Leather Research Chemist, and are given below :—

	Tans.	Non Tans.	Insoluble
	(Calculated at 10 per cent moisture.)		
Cassia auriculata bark—			
Five years old	22·31	9·82	57·87
Four years old	20·08	10·58	59·34
Three years old	20·33	9·65	60·02
Two years old	19·98	11·33	58·69
One year old	19·95	11·59	58·46

Lac.

A regular working scheme for lac operations in the Cumbum Valley, Madura District, was prepared by the Assistant Forest Utilization Officer, and submitted to the Conservator of Forests, and it is under examination. In the meanwhile, operations on the general lines indicated in the working scheme are being carried out at the Vannathiparai Lac Farm. The total outturn (consisting of grain lac and dust lac) obtained during the year 1934-35 was 11,876 lbs. Adding to the above, 2,551 lbs. 1 oz. of old stock left on 1st April 1934, the quantity available for disposal was 14,427 lbs. 1 oz. A total quantity of 11,541 lbs. 1 oz. was disposed of during 1934-35, leaving a balance of 2,886 lbs. on 1st April 1935.

The balance of 2,886 lbs. also was afterwards disposed of to the Superintendent of Prisons, Madras, and Messrs. K. B. Prabhu and Co., Calicut.

The supply to the Superintendent of Prisons, Madras, was made at the agreed rate of Rs. 25 per maund of f.o.r. Madras; the average rate obtained by consignment sales through the Agency of Messrs. Thomas and Co., Calcutta, was Rs. 38-5-3 per maund. Sales made by private treaty were at Rs. 25 and Rs. 30 per maund (of 82 lbs.) *ex*-depôt Cumbum. Samples of lac dye, lac dust and stick lac were also supplied to various firms. Lac operations on a very restricted scale have also been

carried out in the Salem North division and the lac produced is mainly converted into shellac and wood-polish and supplied to Jails, Industrial Schools and various commercial firms.

The supply of wood polish was made from the Salem North division. Some 220 gallons were disposed of during the year, and the revenue realised therefrom was Rs. 907. The marketing of lac and other subsidiary products is a technical matter and has not proved too easy. The Assistant Forest Utilization Officer has visited Calicut, Kumbakonam, Trichur and Trichinopoly in that connection.

NORTH-WEST FRONTIER PROVINCE.

Minor Forest Products.

Digitalis seed, obtained from Kashmir, was sown in a nursery in the Kagan division, and the plants were subsequently put out in a blank in a blue pine forest, at an elevation of 7,750 feet. This experiment has been entirely successful, and has demonstrated that digitalis can be grown in Hazara just as well as in Kashmir.

The seed of a sunflower, which is now being grown as a fodder crop in the Punjab, was obtained from the Punjab Agricultural Department, and tried experimentally at various elevations in the Galis division. It has done remarkably well at all elevations from about 2,000 to 8,000 feet. A considerable quantity of seed has been collected and further areas will be sown next year.

PUNJAB.

Resin tapping.—In the Rawalpindi East division, no improvement in resin yield was obtained with the reduction of channels from 1,000 to 800 and increase in the frequency of refreshening from 4-6 per month.

Lac experiments.—Lac cultivation was continued in Rawalpindi East division. The lac brood did not flourish on wild *Zizyphus*, but did better on *Zizyphus jujuba.*

Bhabar grass.—Record of observations in grass plots was continued in the Simla division.

UNITED PROVINCES.

The only points of possible interest outside the province are :—

(*a*) That the extraction of fat from the drupes of *Rhus cotinus* sent from Chakrata to Dehra Dun showed the yield of fat was too poor to be worth while, being only 1 per cent.

(*b*) The attempt to create a sale for bamboo tops for umbrella handles was dropped owing to the adverse report of the Forest Economist. The excessive taper and thickness of the nodes make the *Dendrocalamus* tops unsuitable.

APPENDIX I.

List of Provincial Forest Publications of 1934-35 (excluding the Forest Research Institute Publications).

ASSAM.

1. Flora of Assam, Vol. I, Part I.
2. Assam Forest Records (Botany) Vol. I, Some new species of Assam, A. Dass.

Indian Forester—

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U. P. Forest Leaflet No. 2 of August 1934.—Preliminary note on mulberry (*morus alba*) with reference to its propagation in the United Provinces, E. C. Mobbs.

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Protecting Naini Tal from landslips by reclamation of denuded hills, M. A. Kakazai.

Regulation of the Selection Yield, E. A. Smythies.

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Statement showing rank, designation and address of Forest Officers employed exclusively on research work in the various Provinces during the year 1934-35.

Serial No.	Name.	Designation.	Address.
1	Mr. A. Das, Deputy Conservator of Forests.	Attached to the Direction Division on special duty, Assam, (for part of the year).	Shillong.
2	Mr. C. S. Purkayastha, Extra Assistant Conservator of Forests.	Attached to the Direction Division on special duty, Assam, (for rest of the year).	Do.
3	Mr. C. K. Homfray, Deputy Conservator of Forests.	Silviculturist, Bengal .	Darjeeling.
4	Mr. F. C. Osmaston, Deputy Conservator of Forests.	Forest Research Officer, Bihar and Orissa.	Ranchi.
5	Mr. R. W. V. Palmer, Deputy Conservator of Forests.	Silviculturist, Burma .	Maymyo.
6	Mr. C. W. Scott, Deputy Conservator of Forests.	Forest Economist, Burma, (for part of the year).	Rangoon.
7	Mr. M. N. Gallant, Deputy Conservator of Forests.	Forest Economist, Burma, (for rest of the year).	Do.
8	Mr. D. J. Atkinson, Deputy Conservator of Forests.	Forest Entomologist, Burma, (for part of the year).	Maymyo.
9	Mr. P. F. Garthwaite, Deputy Conservator of Forests.	Forest Entomologist, Burma, (for rest of the year).	Do.
10	Mr. H. C. B. Jollye, Deputy Conservator of Forests.	Silviculturist, Central Provinces.	Nagpur.
11	Mr. A. L. Griffith, Deputy Conservator of Forests.	Silviculturist, Madras .	Ootacamund.
12	Mr. Ishwar Das Mahendru, Extra Assistant Conservator of Forests.	Divisional Forest Officer, Silvicultural Division, Punjab, (for part of the year).	Lahore.
13	Mr. Partap Singh, Deputy Conservator of Forests.	Divisional Forest Officer, Silvicultural Division, Punjab, (for rest of the year).	Do.
14	Mr. Udo Singh Madan, Extra Assistant Conservator of Forests.	Attached to the Silvicultural Division, Punjab, (for part of the year).	Do.
15	Mr. Ram Saran Chopra, Extra Assistant Conservator of Forests.	Attached to the Silvicultural Division, Punjab, (for rest of the year).	Do.
16	Mr. E. C. Mobbs, Deputy Conservator of Forests.	Silviculturist, United Provinces.	Naini Tal.
17	Mr. Sohan Singh Negi, Extra Assistant Conservator of Forests.	Assistant Silviculturist, United Provinces.	Do.
18	Mr. Chandra Mohan Johri, Extra Assistant Conservator of Forests.	Ditto .	Do.

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